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PRESENT PRACTICE IN CROSS-CONNECTIONS IN CALIFORNIA

VIEWS OF THE STATE DEPARTMENT OF PUBLIC HEALTH[1]

BY E. A. REINKE[2]

The rules and regulations of the State Board of Health governing dual water supplies and cross-connections require that there shall be no physical connection between a private supply or system and a public water system without a permit therefor granted by the State Board of Health. Copies of the regulations, which were adopted in November 1919 and amended May 12, 1924, have been furnished to all waterworks and health officers in California.

In considering these regulations the State Board of Health held that the water department or company should exercise the same precautions in protecting its distribution system from contamination as it uses in protecting its sources. This should be done with even greater care because no safeguards such as filtration or chlorination are provided after the water has once entered the distribution system. Private individuals have no more right to cross-connect their private

[1] Presented before the California Section meeting, October 6, 1927.

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supplies with the public supply than they have to tap a power line, telephone line, sewer system or the public water supply mains, and it is up to the water works men to see that no such connections be made and that those which exist be severed. They should take the necessary steps, legal or otherwise, to accomplish this result.

The rules and regulations read in part as follows:

(2) There shall be no physical connection between such a private source of supply or system and a public water system without a permit therefor, granted by the State Board of Health.

Dual water supplies and sources with which cross-connections exist, or is desired in any form to any public water supply system, shall be held as subject to all the provisions of the Sanitary Water Systems Act. All persons, firms, corporations, public utilities, municipalities, or other public body or institution supplying water for domestic consumption, shall make separate application for permit, under the provisions of the Sanitary Water Systems Act, to supply water from each and every such dual source of water supply or sources with which there exists or it is desired to make any cross-connection.

We interpret this to mean that permits are to be applied for only when the purveyor desires to use the private supply for auxiliary purposes. In other cases no permit is necessary but one may be applied for.

Failure to obtain permit so to do, or aiding or abetting in the making or use of said dual supplies or any cross-connection to a public system without obtaining said permit, shall be adjudged as a violation of the provisions of the Sanitary Water Systems Act and subject to all of the penalties provided in said act.

(3) Water companies or municipalities now or in future furnishing water for domestic purposes, regardless of whether an unrevoked domestic water supply permit from the State Board of Health is held, shall be held responsible to its consumers for pollution of the public system by violation of section (2) and shall forbid service to premises maintaining cross-connections which may pollute the public system, or shall prevent the pollution of the public system by other means acceptable to the State Board of Health. Violations shall constitute sufficient grounds for revoking any domestic water supply permit.

(5) City officials and health officers shall be urged to investigate from time to time, by inspections and laboratory control, the condition of safety or private sources of supply.

CROSS CONNECTIONS IN THE EAST BAY CITIES[1]

By J. D. De Costa[2]

The term cross connection as used in this discussion may be briefly defined as a physical connection between a public and private water supply whereby a flow of water from the private to the public system is possible.

The distribution system of the East Bay Water Company is cross connected with approximately 400 private or secondary supplies. The water from these privately owned sources vary widely in physical appearance, mineral content and bacterial quality. Some are reasonably safe whereas others are dangerously polluted.

Where the object is to develop large volumes of cheap water for some industrial use, or fire protection, little or no consideration is given to its sanitary quality. Shallow wells inadequately protected against the inflow of surface drainage and in the proximity of sewers are common occurrence. Numerous installations obtain their water directly from creeks and the estuary (which is a salt water branch of San Francisco Bay). These sources of supply are subject to contamination at all times.

The cross connections are made by the consumer for convenience and reliability of operation and without reasonable precautions for the protection of public health. In fact the usual procedure is to use the easiest, cheapest and most direct means of connecting the two systems. Secondary supplies, of course, have a legitimate use, but in the writer's opinion only when such supplies are safely separated from the public water system.

East Bay Water Company officials have for many years considered cross connections a potential danger to the health of the community and have done everything within their jurisdiction to abate the ever increasing menace. The fight has been uphill and fought single handed. Private individuals are not as a rule prone to listen to the advice of a public utility where such advice affects them in terms of

[1] Presented before the California Section meeting, October 6, 1927.

[2] Assistant Sanitary Engineer, East Bay Water Company, Oakland, Calif.

dollars and cents or inconvenience of operation. They immediately form the opinion that the public utility merely wishes to further its own interests.

When check values were in vogue an extensive survey was made of the then existing cross connections and a request made that check valves of approved design be installed. The company met with strong opposition and after about two years of costly investigations the campaign ended with approximately thirty per cent complying with our request. It should be understood that we had no authority to force the issue.

Early in 1926 we decided to attack the problem from a different angle. Samples of water were collected from the more conspicuous private fresh water supplies in the various East Bay cities, and bacterial and partial chemical analyses made. A total of 102 sources of supply were sampled. The results of the bacterial analyses may be briefly summarized as follows:

Of the 102 samples collected and analyzed

23.5 per cent showed	100 per cent positive colon
7.8 per cent showed	75 per cent positive colon
5.9 per cent showed	50 per cent positive colon
16.5 per cent showed	25 per cent positive colon

or 53.7 per cent of the samples analyzed showed colon.

Of the samples not showing colon 19 per cent showed an agar count in excess of 100 bacteria per cubic centimeter.

The results of these analyses brought to our minds more forcibly than ever before the apparent danger to public health and the necessity for a more definite and positive program for removing the source of danger. We have learned through experience that check values do not furnish adequate protection. Regular inspections of check valve installations show that they do not offer more than 75 per cent protection. Similar experiences have been obtained elsewhere. In fact they are no longer recognized as a safety measure by health authorities.

The ultimate solution is obviously to discontinue the practice of cross connections entirely, in effect to disconnect those existing and prevent new installations. To carry out such a program, health laws governing cross connections and police powers to enforce them are necessary. The company being without proper jurisdiction, application was made to those with authority for assistance. First we presented our problem and laboratory findings to the State

Department of Public Health, and together we gave the subject a great deal of thought and study and after months of deliberation concluded that the existing State Board regulation, although never given a trial, was not practical of enforcement on a large scale.

We next brought the matter to the attention of the local health officers. Some professed total ignorance of the existence of cross connections in their city, and none fully appreciated the seriousness and extent of dual supplies. After making a few investigations, however, they were all in agreement that a potential danger existed and that the secondary supply should be separated from the public system. More than one year has elapsed and no definite action has been taken. In the meantime the number of cross connections and dangers attached thereto have steadily increased.

What is the answer? Can it be that the public in general is not interested in the safety of its water supply, or is it that the water works men and public health officers upon whom the public depends for a safe water, are negligent in the performance of their task? Surely we will all agree that, if the public knew the dangers to which they are exposed, they would rise in arms against further use of cross connections. The answer then must be that those entrusted to safeguard the public health have overlooked one important source of contamination in permitting the practice of cross connections.

Health and water works officials throughout the country are taking an active interest in dual supplies, especially in those states or localities where serious outbreaks of typhoid fever and other intestinal diseases have occurred as a result of polluted water entering the public water system through cross connections. In California there has been a laxity in active interest. Perhaps due to the fact that no serious trouble has resulted. The time is coming, however, when we will be forced to face the issue. Shall we wait as others have until there is loss of life? In the writer's opinion it is high time that some organized body take an active interest and start action. We need public health laws; laws that are effective and enforceable and law and educational campaigns to teach the people the real dangers to which they are exposed.

In conclusion, the writer feels that it is quite appropriate and in order at this time to propose that a resolution be adopted at this meeting to the effect that the State Department of Public Health and the Railroad Commission of California be requested to promulgate such rules and regulations as may be necessary to eliminate the ever increasing danger resulting from cross connections in this state.

CROSS-CONNECTIONS IN LOS ANGELES[1]

By Carl Wilson[2]

Los Angeles has not had as much trouble we are glad to say as the East Bay Water Company. But we have had some trouble with cross-connections in the Harbor District.

We have had no trouble in the form of disease, but awfully bad water, and something had to be done to take care of bad water conditions. We might say in the beginning that our records show the existence of no cross-connection at all. When cross-connections were suspected as the cause of bad water conditions everybody told us there were none. It was very difficult to locate them; so we had to go at things a little differently.

Our department is perhaps a little bit more arbitrary than the East Bay people, and sometimes we do things other people might not try.

We started on this basis: The State Board of Health, or rather the Public Health Laws of the State of California have very broad powers. It is stated specifically that the burden for all pollution of water shall be laid on the individual who allows it or who causes it, not upon the water purveyor himself. That was fine and dandy; and that enabled us to attack it from that side.

Secondly, the Charter of the City of Los Angeles places on the Chief Engineer of the Water Department the burden of protecting the water supply. He can do whatever in his judgment may be necessary, without recourse to special ordinances passed by the city.

So, when the State Board of Health adopted a resolution prohibiting cross-connections,—the resolution that Mr. Reinke read, the Chief Engineer of our department said we would adopt that as effective in our department. He immediately made a rule that every cross-connection must be abolished. That left us ready to go ahead.

The penalty he imposed was the immediate disconnection of the service,—that is, no one was to be served until cross-connections had

[1] Presented before the California Section meeting, October 6, 1927.

[2] Chemist, Water Department, Los Angeles, Calif.

been removed and all the premises inspected by our inspector and passed on to our satisfaction.

We thought we would start the work on the Harbor District. We went first to the big oil companies. One of them assured us that they had no cross-connections. Another said, "Yes, we have;" and we started to inspect and found cross-connections running from 6 down to 2 inches. Some of them were protected by single check valves and gate valves, some by double valves and some by a hand operated globe valve only.

Quite a bit of opposition was created when we asked to have the cross-connections removed. They told us they must have them for fire protection purposes; that the fire department and the Board of Underwriters would get after them; that there would be insurance forfeiture and everything else would happen; but we were firm.

When the oil companies, who are most belligerent, took the matter up with the fire department, the latter wrote a letter and asked that we allow them to remain if properly protected. We told them we were not going to do it, that we had adopted the State Board Resolution and that any private fire service might be connected to receive water from our system if they had an elevated tank with a pipe going to the top of the tank to deliver water into it in such a way that the water could not get back into the line. The fire department gave us their coöperation by approving our regulations and withdrawing their opposition.

The Board of Fire Underwriters never made any remonstrance.

We served notices on each offender known to us at the time, sending them copies of the State Board Resolution and giving them a certain time limit within which to remove the connections. The time limit varied from 24 hours to 2 weeks, depending on conditions at the plant.

Then we detailed an inspector who started from one end of the Harbor District and inspected every industrial plant, including the canneries and oil refineries and docks and everything else. He unearthed finally over 20 cross-connections, some of them at fish-canneries, which were the ones causing the most trouble. Those have all been eliminated and we have at the present time a regular reinspection every three months.

It takes pretty nearly the three months for the inspector to get around, so one man's full time is used the year around.

PASADENA'S METHOD OF HANDLING CROSS-CONNECTIONS[1]

By M. S. Jones[2]

From the time the city of Pasadena took over and consolidated the various water companies into one system, there has been the problem of cross-connections between the public supply and private water systems. In our community there are many consumers who have a water supply from their own wells or tunnels; others who have facilities for storing water upon their premises or who use the waste from swimming pools for irrigation. Consequently there existed a considerable hazard to the public health due to the existence of cross-connections between the city and private water systems.

The city authorities have been aware of the danger which existed for a long time. It was felt that entire dependence could not be placed on gate and check valves and other mechanical devices which had been in use. After careful consideration and investigation it was decided that the best and only safe method of procedure was to eliminate entirely all physical connection with these private water supplies, and to make the owner or occupant responsible if a cross-connection were allowed to exist upon his premises.

Accordingly in the fall of 1926, an ordinance was framed and presented to the City Board of Directors for their approval, giving the Water Department the authority to order the discontinuance of any cross-connection. The ordinance reads as follows:

Section 32 (*b*). It shall be unlawful for any person, firm or corporation to cause a connection to be made or to allow one to exist for any purpose whatsoever between the city water supply and any other source of supply.

All owners or occupants of premises obtaining water from the City of Pasadena and another source of supply shall file a statement with the Chief Engineer of the Pasadena Water Department of the non-existence of such connection and shall agree not to permit any such cross-connection.

Violation of this section shall constitute a misdemeanor and any person, firm or corporation who or which shall be found guilty of the violation hereof

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[1] Presented before the California Section meeting, October 6, 1927.

[2] Assistant Chief Engineer, Water Department, Pasadena, Calif.

shall be punished by a fine not exceeding Five Hundred Dollars ($500) or by imprisonment in the City Jail for a period not exceeding thirty (30) days, or by both such fine and imprisonment.

In addition to the foregoing penalty city water service shall be discontinued upon any premises upon which there is found to be a connection between the city water supply and another source of water supply, and such service shall not be restored until such cross-connection has been discontinued.

It will be noted that the ordinance makes it a misdemeanor, subject to both fine and imprisonment, to allow a cross-connection to exist. Such a connection is also contrary to the rules and regulations of the Pasadena Water Department and therefore water service may be discontinued from such premises. Both of these provisions were necessary as the territory served by the Department lies both within and without the corporate limits of the city.

Upon passage of this ordinance a list was made of all consumers having a private water supply, together with those users upon whose premises a swimming pool, auxiliary storage tanks, water softening devices or sewage disposal plant existed. A circular letter was sent to each of these, advising the consumer of the reasons for the passage of such ordinance, together with a copy of the ordinance. A blank form was also enclosed for the owner or some other responsible person connected with the establishment to acknowledge the receipt of a copy of this ordinance and to certify that no connection existed or would be allowed to exist between his private system and the city mains. He also stated the nature of his supply, and the presence of any swimming pool, storage tank, water treating device or sewage disposal system upon his premises.

As these signed statements were returned to the Department, each in turn was investigated by one of our inspectors. Our men made certain that all direct connections were cut and a portion of the piping had been removed. Storage tanks were allowed to be used only when the supply was brought in above the high water line. In case the city supply was used as a standby for fire protection and no additional service supplied, the connection was allowed to remain, but every assurance was made that no water could back into the city's mains. In these instances two gate valves were installed on the service with an open $\frac{1}{4}$ inch standpipe extending above the ground between the valves. Should either valve be not entirely seated the leakage through the valve would immediately show through the open end pipe, and in case of fire the loss through this small pipe would not

seriously affect the flow. Whenever valves have been opened by the user, the Department must be notified immediately thereafter.

To date we have found little opposition to the ordinance and no attempts to evade it. Most consumers realized the danger in allowing cross-connections to exist and willingly coöperated with the Department in fulfilling the provisions as set forth in the ordinance, even at considerable expense to themselves. The Pasadena Water Department feels very gratified that a solution has been found to their cross-connection problem and that it has been put into practice without great hardship to their consumers.

ADAPTING THE DISTRIBUTION SYSTEM OF THE NEW ROCHELLE WATER COMPANY TO A NEW SOURCE OF SUPPLY[1]

By P. S. Wilson[2]

The New Rochelle Water Company serves a territory of about 18 square miles, comprising the residential communities of New Rochelle, Pelham Manor, North Pelham, Bronxville, Tuckahoe and Eastchester, a total population of about 75,000.

These communities, situated in the Westchester County Suburbs of New York City and on Long Island Sound have experienced a uniformly sustained rate of growth which is equalled in few places. The number of customers served by the New Rochelle Water Company has nearly doubled each 10 years for the past 40 years and shows every evidence of continuing to increase at a high rate. This rapid growth, together with the rugged and irregular topography of the territory included, creates the principal problems which have been encountered. Elevations ranging from sea level to about 300 feet are included. Figure 1, a reproduction of portion of a United States Geologic Survey map, shows the extent of the territory and its general topography. It will be noted that it is traversed by the valleys of the Bronx River and the Hutchinson River as well as having a general slope towards the Sound and pronounced local irregularities.

The Company has in the past obtained its supply of water from four impounding reservoirs situated on small streams, the watersheds of which are partly within the territory served. The capacity of these reservoirs was exceeded in about 1919 and a connection was made with New York City's Catskill Aqueduct through which increasing quantities of water have been purchased each year. At present about 30 per cent of the water used is so purchased.

The protection of watersheds situated in the midst of towns and villages as these are, has been an increasingly difficult and expensive

[1] Presented before the New York Section meeting, October 28, 1927.

[2] Superintendent of Operation, Community Water Service Company, New York, N. Y.

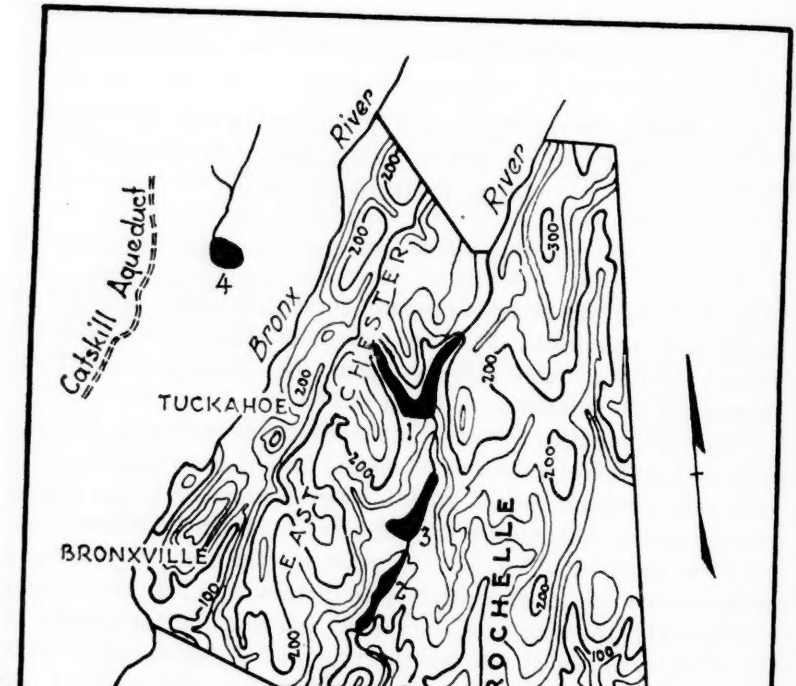

FIG. 1. TOPOGRAPHY IN RELATION TO WATER SOURCES

task. It has been accomplished only through the ownership or control of large areas and by continuous and thorough patrolling. There is even now under construction a county parkway project which will unquestionably increase the work of sanitary control. These facts, together with the rapidly increasing value of land, have made the eventual abandonment of the original sources inevitable. Their replacement by means of water purchased from New York City is the problem with which this paper deals.

The Pitometer Company of New York City was engaged to make a comprehensive study of the entire system with a view to laying out the necessary new works for this change-over so that all portions of the old transmission and distribution system might be used as efficiently as possible and at the same time strengthened at those points where their original capacities had been outgrown. Due to the unusually rapid growth of the plant, it was also necessary to forecast as accurately as possible the location and amount of this growth and to proportion the system accordingly.

For the purpose of this study a most thorough investigation was made of the existing system. In the case of the plant itself, pressure records were obtained at hydrants throughout the system and at many points tests were made of the available flow, using enough hydrants simultaneously so that by noting residual pressures the total capacity could be determined. All of the principal transmission mains were tested to determine their hydraulic co-efficients and thereby the capacity for which they could be relied on.

In addition to this, all the data available were collected which might indicate the probable future consumption of the system, both for domestic and fire requirements. The trend of future growth was studied in order that the needs of each portion of the system might be estimated. A large section of the northern end of New Rochelle and Eastchester are as yet very sparsely built up and these portions include some of the highest territory. There are within the communities served five golf courses of considerable size. The possibility of these areas being changed into residential developments was considered. The future growth of the business areas was investigated and their needs forecast as nearly as possible.

Figures 2 and 3 show the principal features in the transmission and distribution system as they originally existed, with the new features proposed for addition. The old system consists of two levels of distribution, the low territory being fed by gravity from the highest

reservoir, No. 1, and the high territory being supplied by water pumped from the lowest reservoir, No. 2. This arrangement was best because the highest reservoir is the only one which is high enough to feed any of the system by gravity and since it has but little capacity above that necessary for the gravity system alone. Reservoir No. 4 water is available only through boosting it over the intervening rise into No. 1 and Reservoir No. 3 has no outlet except into the stream and thence into No. 2.

The makeup water from the Catskill Aqueduct is put principally into the high service, the same booster pump which handles No. 4 water also serving for this purpose through the manipulation of valves. The storage in the reservoirs makes it possible to remove

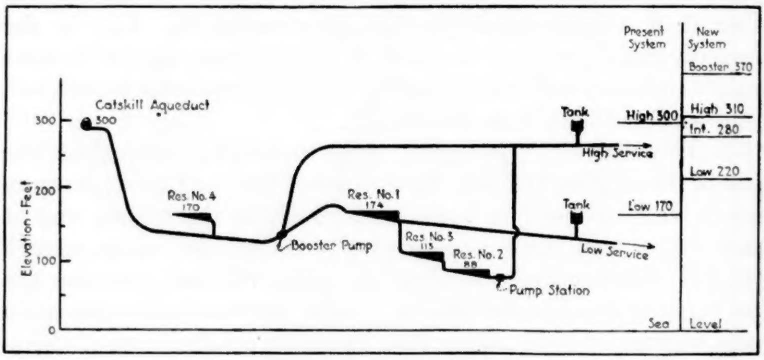

FIG. 2. PROFILE OF SUPPLY SYSTEM

the pump for a period from one task while performing the other. By putting most of the Catskill Water into the high service, its elevation is not wasted, the pump having only to overcome transmission line friction. Reservoirs Nos. 1 and 4, used as a unit together, are about able to serve the needs of the gravity service since they are the two which have the greatest capacity. Should makeup water be required there, however, the piping is so arranged that it can be put into No. 1.

Two levels of distribution are not sufficient to serve the system adequately. The high portions in the territory now being served are not supplied with sufficient pressure and territory which will be extended into in the future is still higher. The pressure levels of the two present services have also necessitated the isolation of a comparatively small high pressure area in the business section of New Rochelle.

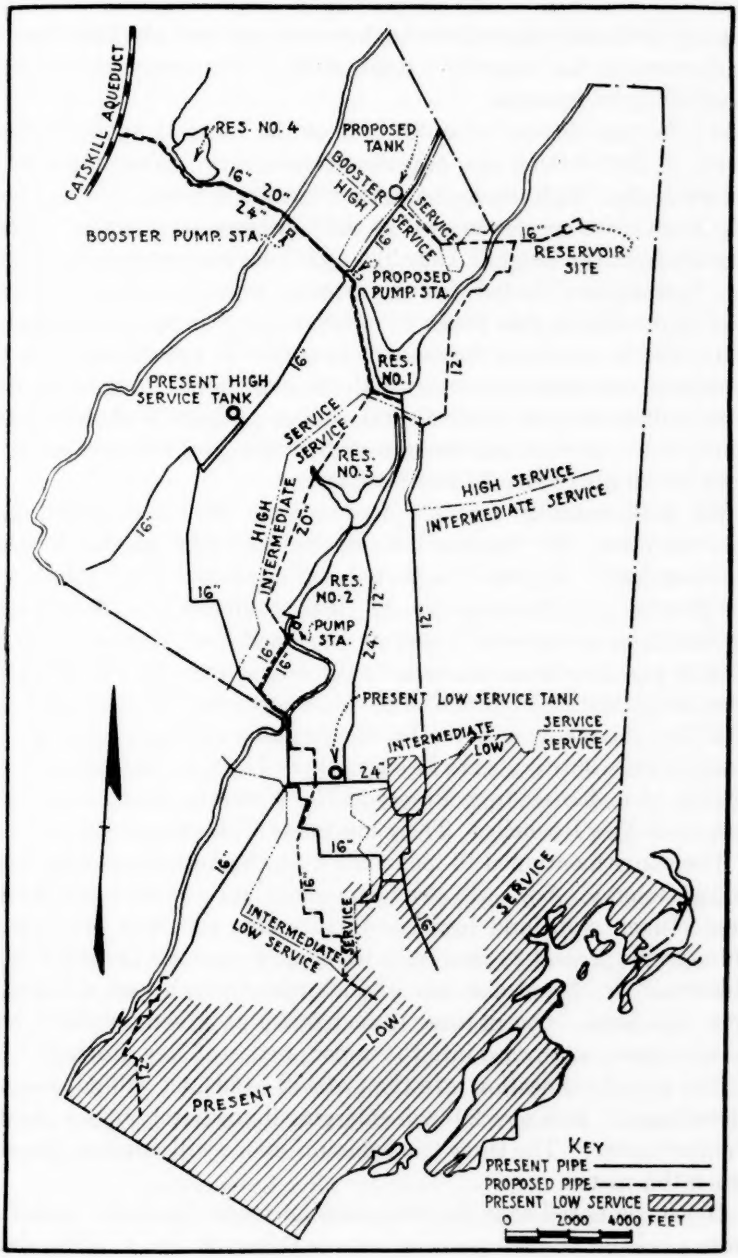

FIG. 3. SUPPLY AND TRANSMISSION SYSTEM

This has caused difficulty in providing ample transmission main capacity both into this isolated high service area and also into the low service area to the immediate south of it. The supply to this area is cut off by its presence.

For the new system fed entirely from the Catskill Aqueduct four levels of distribution are considered necessary. The upper two, known as the "high service" and the "booster service," are pumped. The next lower service known as the "intermediate service" is fed directly from the Catskill Aqueduct and the lowest service, known as the "low service," is fed through pressure reducing valves. It will only be possible in this paper to mention the principal transmission mains and to point out the manner in which the present ones are reconnected and utilized together with the new ones to bring the supply from a different and more distant source. Figure 3 shows all the mains of the present and the new distribution and transmission systems which are of size 12 inches or larger.

We shall consider first the feeders from the Catskill Aqueduct southward into the "intermediate service" and through that into the "low service." At present a 16-inch pipe goes from the Aqueduct to the lower end of Reservoir No. 1. It is paralleled by a 20-inch pipe for the distance between Reservoir No. 4 and Reservoir No. 1. This 20-inch pipe is to be extended up to the Aqueduct and down along the west side of the Reservoirs to the foot of Reservoir No. 2 where it will feed into the mains now fed by the pumping station at that point. Feed by this route is also to be strengthened by the duplication of the present 16-inch main from Reservoir No. 2 into the principal business section of New Rochelle. These mains are all shown on figure 3.

The above mentioned 16-inch main from the Aqueduct to the lower end of Reservoir No. 1 will also be paralleled for its entire length by a new 24-inch main and together these mains will feed the system through the present 24-inch main which now conducts the water from Reservoir No. 1 and also two 12-inch mains which lead southward from this point. One of these 12-inch mains at present conducts high service water northward into the upper portion of New Rochelle.

The actual connection into the Catskill Aqueduct will not need to be enlarged. It is now 20-inch enlarging immediately into a 24-inch Venturi meter. The three transmission mains will connect directly below this meter.

It will be noted that the transmission mains from the Aqueduct cross a present 16-inch main just above Reservoir No. 1. The water

for the new high service will be pumped at this point into this 16-inch main which with its laterals covers the western section of the proposed high service area. This main will be extended as shown up to the proposed new reservoir and from thence as needed feeders will extend into the high northern end of New Rochelle, now undeveloped, which will form the eastern section of the high service.

The "booster service" will comprise at present only a comparatively small area of the extremely northern end of the territory which is too high to be fed from a reservoir. It will be supplied from an elevated tank located as shown in figure 3 and the water will be pumped in the same pump station before mentioned which supplies the high service. A duplicate main now existing will conduct this water from the pumps to the tank. When the area around the new high service reservoir develops, it will be necessary to extend this booster service to include those portions too high to be fed from the reservoir.

It is to be noted that in the new plans the present steel tanks will both be abandoned. Unfortunately neither of them are at such an elevation that they can be used.

Under the new method of supply there will necessarily need to be greater dependence placed upon the integrity of comparatively long supply mains for continuity of supply. The safety of this will be assured not only by the presence of several parallel mains, but by the new reservoir before mentioned. It is planned that this reservoir will be a covered concrete and earth bank reservoir of at least 5 million gallons capacity. It must be remembered that the Catskill Aqueduct itself is a source of more than usual dependability, being the principal supply conduit for New York City and normally carrying from 400 to 600 million gallons per day.

The pumping for the new system will all be done in the single station where there will be a sufficient duplication of equipment to insure dependable operation both into the high and the booster service. As an additional factor of safety in case of emergency the booster service may be fed from the high service at somewhat reduced pressure. The attendant at the pump station will have control of the valves necessary for this as well as those which may be used if needed to allow water from the reservoir to pass into the "intermediate service" and from thence into the "low service."

The use of pressure reducing valves is one of the features of the new system. Through their use some of the disadvantages of employing several levels of distribution are overcome. The carrying of the

mains of one pressure through a different pressure area, and the consequent duplication, is avoided. The same transmission mains feed both services and adequate capacity for each is more easily provided. Also, the reservoir storage is made more readily available to the lower level in case of emergency.

A special study is being made of the method of installing these pressure reducing valves in order to obviate mechanical difficulties as far as possible. They will be installed in carefully constructed concrete vaults where they will be protected from frost and dirt and where there will be provided facilities such as gage connections, valves, blow-offs, etc., so that they may be regularly inspected and tested.

In connection with the redesign of the distribution system for the new source of supply there was another problem to be met which considerably complicated the task. The present system had in it several portions which were in need of immediate reinforcement. It was necessary to remedy certain conditions even before the whole system could be shifted over to the new source of supply. This required that not only must the old features of the plant be adapted to the new system but new features must be added to the old plant which later must be adapted to the new system.

One of the items of this reinforcement consists of the new 16-inch main from the pumping station at the foot of Reservoir No. 2 into the business section of New Rochelle. The part which this new main takes in the new system has already been mentioned.

Another item of immediate reinforcement consists in the increasing of the pressure in a high section of the old low service area in Pelham Manor in the southwest corner of the territory. This is done by the installation of a pressure reducing valve in a temporary location where it will feed from the old high service into a new 12-inch feeder shown on figure 3. This feeder will later form a valuable line into this portion of the territory since it will then be fed by a present 16-inch low service main.

In order to strengthen further the present system the pressure reducing valves which will eventually be used to feed from the direct into the low service are all to be installed immediately in temporary locations between the present high and low services. In these temporary installations they will be set so that under all normal conditions they will remain closed. Under conditions of excessive drop in pressure on the low service side as in case of a fire draft they will, however,

open up and make the high service feed available into the low service. This will strengthen that section of the present low service, previously mentioned, which is somewhat isolated by the high service business section of New Rochelle.

It will be appreciated that in this paper only the principal features in the necessary works have been pointed out. Considerable reinforcement is necessary and is being provided among the smaller portions of the distribution grid. It is hoped, however, that the general nature of the whole work has been made evident.

The estimated cost of all of the works contemplated, including the change-over in source of supply and all needed reinforcements, is approximately $1,200,000 and the work is now in progress.

DISCUSSION

EDGAR K. WILSON:[3] Mr. Wilson has mentioned in his paper most of the principal features of this redesign problem. There are some points which may bear a little enlargement in order to present the problem more clearly.

First of all it may be of interest to consider the complications caused by local conditions. Mr. Wilson has spoken of the abandonment of the reservoir system, which, of course, is the fundamental reason for the redesign. This change is expected to take place in not over 5 years; and any improvements recommended for the period previous to the change must be very carefully considered in order that they will be available and will not conflict with the whole scheme after the change has taken place. Pipe lines which will be needed in the future will give little or no relief to present poor supply conditions; and lines which would obviously relieve the present conditions might not be of much advantage for the Catskill Supply.

A second complication is easily seen by an inspection of the map of the entire system. It will be noticed that the southern section is cut off by the main line of the N. Y., N.H., & H. R.R. and that points where streets cross under the tracks are not numerous. This makes certain routes for large mains fixed in advance.

A third complication presents itself in the irregular topography of the area supplied, as shown by Mr. Wilson. This irregularity is manifested in the numerous hills and valleys which are encountered throughout the system. In an area having a fairly even slope the

[3] Chief Engineer, The Pitometer Company, Engineers, New York, N. Y.

laying out of services so that the general pressures of the whole system may be fairly uniform, is simple; and it is not difficult to lay down routes for reinforcing mains. Where, however, as in New Rochelle, a hill in a high service section rises almost to a point where the pressure will not supply the houses; or, on the other hand, where a valley occurs so deep that the pressure is excessive, then the problem is somewhat complicated. To take care of these conditions it may be necessary to use long sections of existing pipes, to the exclusion of the present side feeds which they were designed to supply, creating many dead ends and cutting off natural feeders. Irregular pressure service area outlines will usually produce these effects, unless special mains are laid to feed into small areas.

Still another difficulty arises from the fact that a very considerable portion of the area, especially in the northern part of the city of New Rochelle and the Town of Eastchester, is not yet subdivided and no north and south streets are laid out available for feed mains. The land is held in large parcels, usually long and narrow, with the short dimension north and south. On this account it is impossible to carry feed mains from the foot of present Reservoir No. 1 to the eastward to give a needed supply into the system from its easterly border.

To overcome all these complications without a considerable expenditure is impossible, but the endeavor has been made to obtain the required results as economically as may be consistent with efficiency. This is especially shown in the change from the present to the Catskill supply. Only such mains are recommended as will be of future use, depending for the necessary amplified supply in the low service on pressure regulators which will let the water pass from the present high service into the low under heavy fire draft. This allows the use of the present and proposed high service conduits for a double purpose; and, with slight changes at small expense, the same valves may be used for the permanent layout between the Catskill or proposed Intermediate Service and the proposed Low Service.

The effect of irregular pressure service area outlines has been mentioned. This is very well illustrated by the conditions in New Rochelle, where the feeds into the present Low Service have been very badly curtailed by the necessity of extending the High Service into the business section of the city.

In addition to having its sub-feeder mains cut off the Low Service has for its sole source of supply a 24-inch main from No. 1 Reservoir.

A loss of head test showed this main to be in rather bad condition due to friction losses, the value of "c" in the Williams-Hazen formula being only 65 for the whole length of main. Tests of approximately equal lengths of the main showed that the upper half is in somewhat worse condition than the lower, the coefficients being 58 and 76 respectively. This would seem to indicate that silt in the sags of the line may be responsible for a considerable amount of the loss. This condition can be remedied by cleaning the main; but it cannot be taken out of service at the present time. Reliance for increased protection must therefore be placed on the present high service in case of fire in the present low service, and this is the principle reason for the pressure regulating valves mentioned in Mr. Wilson's paper. These valves will be so set as to pass no water except in case of drafts too heavy for the 24-inch main to care for.

It is impossible by main construction to provide relief for this condition economically until the Catskill supply is brought in, at which time recommended construction will allow the 24-inch main to be put out of service long enough for cleaning.

It is obvious that a parallel 24-inch main from Reservoir No. 1 to Mayflower Avenue would relieve the condition. However, since the present high service pumping station will be abandoned the present 16-inch main and the proposed 16-inch main mentioned by Mr. Wilson for the relief of the business center would be of little value for the Catskill supply between the present High Service pumping station and Mayflower Avenue. In addition a 20-inch main recommended between Reservoir No. 1 and the High Service pumping station which is needed at once for this supply would be superfluous under the new conditions if the 24-inch main is duplicated.

For these reasons it seemed wise not to recommend such duplication and to depend on the old 24-inch main with the high service as a standby through the pressure reducing valves.

Now, a few words about standpipes and tanks. A short time ago one of our members gave a very interesting paper on the use of tanks to save excessive sizes of mains. The conditions in New Rochelle are in several instances ideal for such construction, but only one standpipe was recommended. At the point selected, the pressure at the street was only about 15 pounds, while the pressure in the houses with water running was very low due to old service pipes. Adequate pressure would be assured by the proposed tank, as well as

needed fire protection. Several hearings have already been held on the matter of this tank, much objection being manifested. It is perfectly possible to go ahead with the present pressures, but it does not seem practicable to increase the pressure and regulate by means of the pump alone.

This is another instance of how public opinion runs counter to the needs of a community when the aesthetic viewpoint is taken.

GROUND WATER RECESSION IN WISCONSIN[1]

By Leon A. Smith[2]

The effect of the recession of ground water in Wisconsin is of considerably more importance to our citizens than is the case in many other states, because 244 municipalities out of the 284 in Wisconsin which have public water supplies obtain water from wells. Of these, 163 or 57 per cent obtain water from deep wells, largely from Potsdam sandstone. For the purpose of this presentation I have considered deep wells exclusively, as the variation in water levels in shallow wells is very great, depending upon the sand and gravel deposits, and no general conclusions can be drawn regarding them.

It is extremely difficult to get accurate records of old wells, but I have been able to assemble from information submitted to me by waterworks superintendents and consulting engineers a fairly accurate statement as to the original and present water levels in 25 municipal wells in Wisconsin. These data are shown in table 1. From these records it is apparent that there is a considerable recession of the water in deep wells. The average date of drilling of these 25 wells was 1899. The average diameter was 9 inches and the average depth 790 feet. The original static level on the average was 2 feet above the surface of the ground. At the present time the average elevation is 28 feet below the surface of the ground. This is a drop of 30 feet in twenty-eight years, or approximately 1 foot per year.

After studying the well recessions and discussing them with waterworks superintendents and consulting engineers, I think that there are three general facts which may be drawn from the experience in Wisconsin. They are:

1. There is always to be expected a considerable drop in the static head of an artesian well basin when wells are first developed. A portion of the original static head is consumed in creating the flow of the wells in use and the decrease in this head continues as long as additional wells are drilled.

[1] Presented before the Chicago Convention, June 9, 1927.

[2] Superintendent, Waterworks, Madison, Wisc.

2. There is a loss of head in wells due to the gradual filling up of the pores in the sandstone by fine material drifting toward the well. There is also a clogging action due to the growth of low forms of plant life such as Crenothrix in the pores of the sandstone at the wall of the well due to the liberation of CO_2 by the reduction in pressure.

TABLE 1

Data on well water recessions in Wisconsin

CITY	DATE	DIAMETER	DEPTH	STATIC LEVEL			
				Original		Present	
				+	−	+	−
		inches	*feet*	*feet*	*feet*	*feet*	*feet*
Prairie du Chien	1865			100		1	
Madison	1882	8	725	4			34
Fond du Lac	1885	4	1,000	2			58
DePere	1885			97		1	
Green Bay	1886	8		81			94
Whitewater	1887		960	19			10
Clintonville	1889	12			89		96
Brodhead	1890	6	1,002	1		4	
Janesville	1890		1,063	28		21	
Oconomowoc	1890	16	729		5		7
Eau Claire	1892	20			12		22
Stoughton	1892	6	1,010	1			8
Watertown	1893		900	20		2	
Clinton	1896		800		33		35
Monroe	1896	4	410	4			16
Elkhorn	1897		1,000		142		195
Wauwautosa	1898	6	1,357	3			12
Sun Prairie	1899		200		5		19
Fort Atkinson	1901	8	752	28		20	
Lake Geneva	1902	12			59		72
Marshfield	1906		70		12		30
Waukesha	1912	6	300				16
Boscobel	1913	12	900				15
Bellville	1914		600	12			
Cedarburg	1922	10	1,210		3		27
	1899	9	790	2			28

3. It is obvious that the water level in wells will recede unless the rate of recharge of the sandstone area is equal to the rate at which water is pumped from that area. Because of the large number of

wells drilled in Wisconsin, it is entirely possible that more water is being pumped from the Potsdam sandstone than percolates into it.

It is not my intention to discuss in detail the situation in all of the cases tabulated, but simply to call attention to four cases that tend to prove some of the above points.

At Clinton, Wisconsin, a well was drilled to a depth of 800 feet in 1896. At that time the water stood 33 feet below the surface of the ground. In 1922 the water had been lowered to 85 feet, at which time the well was shot three times and the water gradually rose to within 35 feet of the surface. This tends to prove that the loss of head in wells in some cases is due to the gradual filling up of the pores in the sandstone.

At Whitewater, Wisconsin a well was drilled to 960 feet in 1887. This well flowed and the water at one time rose 19 feet above the ground level. In 1913 the head had decreased so that the well barely flowed into the reservoir 10 feet below the ground. The well was recased, shutting off all formations down to the St. Peter sandstone, and the head increased above the ground level, although the water never rose to its original elevation. This illustrates a recession in ground water due to improper casing.

Between 1870 and 1890 many shallow wells between 150 and 250 feet in depth were drilled at Watertown, Wisconsin. They flowed under a comparatively high head in quite large quantities. In 1892 a deep well, 900 feet in depth, was drilled and there was a flow of approximately 1000 gallons per minute. Immediately all of the shallow wells ceased flowing in the immediate vicinity of the deep well. This would indicate that the shallow wells were receiving their water by leakage from the deeper formations.

At Madison, Wisconsin, the first well was drilled in 1882 to the depth of 725 feet and the water rose $4\frac{1}{2}$ feet above the elevation of Lake Mendota. Subsequently, additional wells were drilled and all of the wells in the group have been pumped more or less continuously since that time. In 1924 the water had receded to an average of 54 feet, a total recession of $58\frac{1}{2}$ feet. At that time all of the wells in this group were reamed out and cleaned out and the water rose in the wells an average of approximately 20 feet. This emphasizes the fact that all of the recession in ground water levels is not due to decrease of head in the sandstone.

In 1925 a new well was drilled in Madison $3\frac{1}{2}$ miles from this group and the water rose to a height of 2 feet above the elevation of Lake

Mendota, which is within $2\frac{1}{2}$ feet of the original static water level in 1882. Since that time two other isolated wells have been drilled, and in both cases the water rose to an elevation above the lake.

In several cities, notably Kenosha, Fond du Lac and DePere, wells were drilled over fifty years ago and at that time flowed under sufficient pressure to be utilized for domestic purposes without pumping. In practically all of these cases the artesian head has decreased so that the pressure is not sufficient for satisfactory domestic use.

While it is difficult to conclude definitely, it seems apparent that the rate of recession in the ground water level has been somewhat slower in recent years than when the well area was new. From the information that I have been able to obtain, and from my own experience, I feel that the factors affecting the recession of water in wells may be grouped under four heads, as follows:

1. *Leakage* may be due to crevices in the rock below the well casing, or from defective or pitted casings. There may also be a loss of water due to casings rusting out in abandoned wells.

2. *Deposits* in the pores of the rock in the vicinity of wells. These may be due to mechanical clogging by reason of the water stream carrying fine particles toward the hole and depositing them in the pores in the rock in the vicinity of the wells. This clogging may also be due to Crenothrix, or other organic growths on the walls of the wells.

3. *Interference between wells.* This is almost invariably observed when wells are located within close proximity to one another and is purely a local condition which may be largely eliminated by proper locating of wells.

4. *The gradual decrease in the artesian head.* This is largely due to the fact that a portion of the original static head is creating a head in the sandstone. The other important factor is that in all probability more water is being pumped from the water-bearing sandstone than seeps into the sandstone outcrop.

The matter of well recession is extremely important, particularly in the Middle West. I suggest that a date be set at our next year's convention for a round table discussion on the matter of deep wells, with the idea that a system of assembling information can be worked out so that sufficient information may be available to justify conclusions with reference to the future supply of water reasonably to be expected from deep wells.

WATER SUPPLIES FOR AUTOMATIC SPRINKLER PROTECTION[1]

By Karl E. Eppich[2]

The installation of automatic sprinkler equipments is one of the most effective methods yet devised for protection against fire. In cognizance of the high degree of protection thus afforded, the rates charged for fire insurance indemnity are greatly reduced in properties so equipped. A property owner contemplating the expenditure of any considerable amount of money for fire protection is naturally keenly interested in the savings that will result in the subsequent premiums he is to pay for various forms of insurance, purchased to protect himself from pecuniary loss in the event of fire. In order that the maximum credit may be allowed in these rates, this type of equipment is almost always installed in accordance with the specifications of the insurance organization which will thereafter assume the liability. The Mountain States Inspection Bureau, as the representative of a great many fire insurance companies, is called upon to supervise the installation of a vast majority of the fire protection systems installed in Colorado, Wyoming and New Mexico.

In order to obtain uniform treatment, the regulations of the National Board of Fire Underwriters are followed, together with the Advisory Rules of Practice of the Central Actuarial Bureau in Chicago.

Since the prime factor in automatic sprinkler equipments is an ever-ready and unfailing water supply, it is hoped that this brief discussion of this phase of sprinkler protection will prove interesting to this assembly.

AUTOMATIC SPRINKLER SYSTEMS

An automatic sprinkler is a device consisting essentially of an orifice sealed tightly by a cap, held in place by a system of struts and levers, which are held under compression by an alloy designed

[1] Presented before the Rocky Mountain Section meeting, February 7, 1927.

[2] Engineer, Mountain States Inspection Bureau, Denver, Colo.

to fuse at a given temperature. The release of these levers by the fusion of the alloy permits water to issue from the orifice. This water is sprayed by a deflector and falls onto the fire, accomplishing its extinguishment, or holds it in check until the arrival of human assistance, which is called by alarms actuated by the flow of water through the system.

The standard sprinkler orifice is approximately $\frac{1}{2}$ inch in diameter and at 10 pounds flowing pressure will discharge about 18 gallons per minute and cover an area of about 100 square feet. Of course, the volume discharged varies with the pressure. Since statistics have shown that, if high pressure is available when the first sprinklers open, there is a much lesser probability of large volume being required, the requirements vary for the several types of supply.

The supply most generally used in this territory consists of one or more connections to municipal water mains in the vicinity of the risk. These connections are 6-inch or larger, with 4-inch connections used only on very rare occasions. Very seldom are sprinkler connections larger than 8-inch. The municipal water supply is usually satisfactory as far as volume is concerned and may be accepted, providing the distribution system is capable of supplying the required volume at the risk without too great a drop in pressure. If there is a residual pressure of at least 12 pounds per square inch at the highest sprinklers with at least 500 gallons per minute flowing from a hydrant in the immediate vicinity, the supply is considered acceptable for any system having not more than 200 heads in one fire area. If there are more than 200 heads in such an area, the flow required is increased.

To determine the adequacy of the city mains, actual tests are made as follows, when conditions permit. Static pressure is measured on the street hydrant nearest the property, and a flow set up through the hydrant next nearest the property, but in a direction away from the source of supply. This flow is regulated to 500 gallons per minute, or more if required, through the use of pitot gauges and previously prepared tables for discharge through hydrant butts. With this flow established, the residual pressure is ascertained from the first hydrant and from a measurement of the height of the building, the residual under the roof may be calculated.

All city connections are equipped with an outside screw and yoke gate valve at the point where they enter the building, as a means for readily controlling the flow from this source. In addition to this,

there are one or more valves outside, these to be preferably of the post indicator type. Where the posts would interfere with traffic, or are otherwise objectionable, hub end gates are employed. It is not often that the property owner has a key for these valves, and a representative of the water company or fire department must be called to operate them.

Much has been said concerning the danger of a rupture of the main feeder to the sprinkler equipment acting as a bleeder to the municipal distribution system, and in a few widely separated instances such has been the case. This occurred at Salem, Mass., at the time of the great conflagration there and seriously hampered the work of the fire department. No instance of this happening has ever been recorded in this territory and the probability of its occurrence is undoubtedly rather remote.

In some localities the water companies demand that the feed lines be metered and when this is the case, only approved detector meters should be employed as the friction losses under large flows in ordinary meters become prohibitive. In other localities a flat charge, or "readiness to serve" charge is assessed for all connections for fire protection purposes. These charges vary up to $120 per year for a 6-inch connection, increasing as the size of the connection increases.

When a secondary or tertiary supply is employed for the sprinkler system, it is necessary to use horizontal swing check valves to prevent draining the other supplies back through the city mains, in the event of a difference in pressure or a shut-down for repairs in the street. These checks also prevent possible contamination of the municipal water by impure water in the secondary or tertiary reservoirs.

When the risk to be protected is of such a height that the residual pressure in the city mains is inadequate, a so-called booster pump may be installed. These pumps may be driven by steam or electricity, but under all circumstances must be automatic. A reduction of the pressure in the system operates a specially constructed governor which immediately sets the pump in operation and supplies a sufficient volume at the required pressure for any length of time, until failure of the pump or power supplies.

ELEVATED TANKS

Where city mains are not available, or for some reason not desirable, the most common supply is an elevated tank usually called a

gravity tank. The capacity of such a tank is dependent on the size of the system it will supply, the minimum size now acceptable being 20,000 gallons. The sizes range upward from this figure to 100,000 or 125,000 gallons, where the water will be used for yard hydrants as well as for sprinklers.

When an elevated tank is to provide the primary source for sprinkler protection, it must be high enough to provide at least 15 pounds static pressure at the highest sprinklers with the tank almost empty. Practice in this field is for the bottom of the tank to be at least 40 feet above the highest sprinklers, for a primary supply, and not less than 25 feet in any event.

Several types of tank construction may be used, but at the present time circular steel tanks with hemispherical bottoms seem to take preference. The details of construction for each type of tank are outlined in the regulations of the National Board of Fire Underwriters. One important specification that applies to all tanks, however, is that the supports be incombustible.

Gravity tank risers are equipped with a standard expansion joint at the tank, one outside stem and yoke gate valve on the roof of the building if the tank is supported over the roof of a building, and one outside steam and yoke gate at the foot of the riser.

PRESSURE TANKS

When one supply of adequate volume has been provided, a satisfactory secondary source is a battery of one or more pressure tanks. These tanks are located on or near the roof of the building to be protected, and range in aggregate capacity from 6000 to 9000 gallons. Some old pressure tanks are found with capacities as low as 4500 gallons.

These tanks are designed to supply water to the sprinklers at high pressure. If high pressure is available when the first sprinklers open, it is probable that a smaller quantity of water will be needed. The capacity of these tanks is not as great as that of gravity tanks. To produce the high pressure, the pressure tank is filled just two-thirds full of water and air pressure established in the upper third of the tank. When the tank is at the level of the highest sprinklers, this air pressure is 75 pounds per square inch. When the tank is exhausted this pressure is reduced to approximately 15 pounds per square inch. When the tank is located a little below the top line

sprinklers, the initial pressure is increased sufficiently to assure this minimum pressure when all the water has been discharged.

In order to prevent rupture of the supply lines from these tanks in the event of expansion of the riser or settling of the building, a standard swing joint is provided underneath the tank. An outside stem and yoke gate valve should be flanged to the tank in all cases, to permit shutting the tank against leakage in all fittings and joints. A secondary outside stem and yoke gate is installed at the base of the pressure tank riser.

AUXILIARY PUMPS

Where sufficient draught is available and ample power is assured, a standard fire pump is an ideal secondary source. These pumps are constructed in accordance with the National Board specifications and are usually designed to pump 1000 gallons per minute against 100 pounds pressure at the pump. The most desirable capacity depends, of course, on the service to be performed. Where the supply is to be delivered to sprinklers only, a large capacity pump is not required, but, where hydrants are also supplied by the pump, 1000 gallons per minute are generally the minimum.

In risks where high pressure steam is available at all times, positive displacement pumps of the double acting piston type are installed. These are constructed in accordance with the standards and are commonly called "Underwriters" pumps. These differ from the ordinary trade pumps in these major details. Their steam ports, water passages and air chambers are larger, to permit larger discharges without water hammer; the piston rods and valve rods are of Tobin bronze instead of steel; the water pistons, stuffing boxes and rock-shaft bearings are of brass instead of cast iron; and the valve levers are of steel, wrought iron forgings, or steel castings; all to provide a high degree of rust-proofing. This is necessary because these pumps should be reserved for fire service only, and consequently may lie idle for long periods and must be started immediately in an emergency. A considerable amount of auxiliary equipment, such as vacuum chambers, gauges, relief valves and discharge cones, hose valves, sight feed lubricators and a capacity plate, is included with the complete pump.

When steam is not available, electrically driven pumps are used. These are generally two or three stage centrifugal pumps with the impeller specially designed to produce the characteristic curve indi-

cating the best service for each installation. Two separate sources of current are usually required, and together with the necessary control equipment, the cost of such installations is in this territory considerably more than for steam pumps. Consequently they are not so often used.

Pump supplies are generally manually controlled, but can be installed under automatic control, as has been mentioned for the booster pumps.

In localities where pumping engines are used by the fire department, taking suction from a public supply, a siamese connection properly equipped with check vaves is connected to the sprinkler equipment. This permits water to be pumped into the system at high pressure from the outside of the building. These connections are required in this territory, but are not considered as a source of supply. They are installed for emergency use only and are seldom used.

For the protection of risks not under full municipal protection, private yard hydrants are sometimes supplied by the same sources feeding the automatic sprinklers. Any of the supplies we have mentioned, except pressure tanks, may be used providing the capacity is increased sufficiently.

Where more than one supply is to be used, check valves of the horizontal swing type must be provided in each supply, to prevent differences in pressure from exhausting one supply through another. Outside stem and yoke gates should be installed on each side of all checks to facilitate cleaning or repair without the necessity of shutting off more than one supply from the equipment.

PIPING

All underground piping should be made in accordance with the American Water Works specifications for Class C, cast iron pipe or approved by Underwriters Laboratories in Chicago. Steel or wrought iron pipe is generally considered objectionable on account of corrosion, leakage, etc., and because private systems seldom have much repair equipment available. All bends, tees, ells, etc., must be strapped to prevent pulling of the bell and spigot joints under water hammer or settling. Valves in underground piping should be of the post indicator type wherever possible, and if not possible, standard outside stem and yoke gates should be placed in readily

accessible pits. Branch lines for sprinkler equipments should be not less than 6 inches in size, wherever there is a probability of future expansion of the equipment. Where the underground feeds hydrants as well as sprinklers, the underground should be at least 8 inches up to the place where the sprinkler branch comes off.

A standard sprinkler equipment has two sources of supply, one automatic and one capable of supplying water under heavy pressure. Single source equipments, however, are very common in cities where the municipal water supply is acceptable. When two or more supplies are desired, combinations of the sources that have been mentioned, are used, depending on the various conditions surrounding each risk.

Sprinkler piping should not be used in any way for domestic service, as circulation in the pipes greatly increases corrosion, encourages the deposit of sediment and condensation drip. Use of such supplies for domestic purposes has been known to reduce seriously the capacity available for fire purposes and thus greatly impair the efficiency of the equipment.

In designing a sprinkler equipment and its supplies, note should be taken of the number of sprinklers that will probably operate in a single fire. The great majority of sprinkler fires are extinguished by the opening of comparatively few heads and consequently small consumption of water. But in order to provide for the worst probable conditions, the supplies must be much larger than are likely to be required. Statistics kept from 1897 show that 71.5 per cent of all sprinkler fires in which data were available, were controlled by the operation of 5 or less heads, and in only 3.6 per cent were 50 or more heads opened. The value of a sprinkler equipment lies largely in uninterrupted service. Consequently the installation must be so made as to preclude in as large a measure as possible the necessity for shut-downs for repairs.

The subject of supplies has been gone over very briefly in this paper and the details of specific or peculiar installations have not been approached. The requirements as have been outlined are those generally used in this territory, but may be subject to some slight variation under unusual conditions found in any individual risk. Wherever installations of fire protection equipment are contemplated in the States of Colorado, Wyoming and New Mexico, and the resulting fire insurance rates or municipal classifications as determined by the

Mountain States Inspection Bureau are to be used, it is urged that the plans be taken up with that Bureau before construction is begun, in order that the maximum credits may be allowed. This service is furnished without cost, in the interests of our subscribers and in an effort to advance the science and art of fire protection and to reduce the enormous fire waste that is daily consuming such a large portion of our wealth and resources.

FIRE PROTECTION[1]

By George W. Booth[2]

In the year before last, the latest year for which complete statistics are at hand, America burned exactly $559,428,858 worth of improved property. It also sacrificed to the Fire Demon during the same twelve months, some 15,000 lives. This resulted from an average of a fire a minute, day and night, throughout the fifty-two weeks of 1925.

Nor is this all. These figures take no account whatever of all the millions of dollars of contingent loss. They do not include the huge expense of maintaining municipal fire defences. They ignore, likewise, the many millions which in the aggregate had to be struck off the tax rolls of every municipality, since burned property pays no taxes. Nor, again do they embrace that incalculably great loss—the loss due to interruption of business of all kinds brought about through the occurrence of fire. These are major losses. They run into the tens of millions yearly and there is besides a host of minor wastages to be laid at the door of the Flame Fiend. It has, indeed, been conservatively estimated that the loss from fire, taking everything into consideration, tops a billion dollars a year, every penny of which is drawn from the pockets of the public.

These are impressive figures, yet I should like to quote you some which are yet more staggering. The close of 1925 marked the end of the first quarter of the twentieth century. Thus we are afforded an opportunity to review America's fire experience over that period. It has been an eventful term, as everybody knows, possibly the most momentous in the world's history. And although it has been an epoch marked by vast and astounding achievements, not all of these achievements have been of the constructive kind. There has been destruction quite unparalleled. The Great War is not the sole example. There is Fire.

What did fire do to America during these twenty-five years?

[1] Presented before the Indiana Section meeting, February 17, 1927.

[2] Chief Engineer, National Board of Fire Underwriters, New York, N. Y.

From 1901 to 1925, inclusive, it wiped out property reaching the overwhelming total of seven and a half billions of dollars. And where has it gone? Where else, indeed, but up in smoke and down in dust.

And yet this figure is merely the direct loss suffered in those years. Further billions to cover incidental losses must be added by anybody who would form a true picture of the extent to which America suffered from fire during this opening quarter of the most progressive century the world has ever known. It is scarcely a reassuring spectacle.

Let us consider those seven and a half billions by themselves. Together they form a sum difficult to visualize for a moment. Perhaps we might try to translate this abstract sum into terms of the concrete.

Seven and one-half billions is almost twice the amount of all the United States gold and silver coin and bullion in existence. It is one and one-half billions more than the entire national wealth of Belgium. It is a sum sufficient to run the United States Government complete for two years and leave a half billion to spare. It would support both the Army and Navy for a dozen years and in a manner to which they have seldom been accustomed. It exceeds by one half billion dollars the 1926 realty assessed valuation of Manhattan, which of course, is the steepest in the world. At 4 per cent, the interest alone on this sum for one year would be ample to build seven such tubes as the Holland vehicular tunnel which will open to traffic between Manhattan and New Jersey next spring. Finally, to bring it down to terms of your own business—water supply—reflect upon how many systems like the great Catskill supply of New York, which cost $180,000,000, could be constructed with this seven and a half billions!

And this staggering sum was all wasted. In reality it was far worse than wasted, since the psychological effect upon a people of such reckless prodigality cannot help but be one of gradual demoralization. It stands as the fruit of a heedlessness that has been growing steadily on the American public like some malignant disease which, if it is not checked, and checked promptly, in time will break down the economic health of the nation.

If there can possibly be, anywhere in this country, any single individual who doubts the imperative need for curbing this waste—a waste both of lives and of property—let him ponder the foregoing.

And let him further bear in mind that fire waste is absolute. By that I mean that the loss is completely irreplaceable. This is a truism, but like other truisms it is sometimes forgotten. Let me illustrate, just for the sake of emphasis.

Suppose that some marauder breaks into your house and abstracts therefrom your accumulation of silverware; or suppose on your way home from this very profitable meeting some member of the light-fingered gentry should thrust his hand into your pocket and extract your bill fold. What has happened in these two cases? Obviously you have lost, on the one hand, some highly valuable utensils and, on the other, some valuable greenbacks. Either, to you, is a very definite loss, and you mourn it as such. Yet, if we look at it in the cold light of economics, what is your loss is somebody else's gain. In other words, following the theft, there is just as much silverware remaining in the world and just as much money. It has simply changed hands.

But if fire visits your home to-night and lays it low the value represented by that destroyed property becomes non-existent. It is removed from the world as completely as if, in defiance of the laws of gravity, it had been whirled off this planet into space. It is no longer a part of the wealth of the world, and can never be again.

There is, I think, no need of my elaborating any further on these familiar thoughts in connection with America's fire loss. We have considered them sufficiently to have built up in our minds a pretty vivid picture of it. That it can be allowed to continue at its present rate is unthinkable in this day and age and in this country. It must be stopped!

PREVENTION OF FIRE LOSSES

Broadly speaking there are two practical methods by which to attack the problem of fire loss successfully. For purposes of cataloging them, we may call them respectively the way of Prevention and the way of Protection. A combination of both is necessary for complete effectiveness, and yet today more and more emphasis is being placed on the former, or Prevention. This is in keeping with the modern trend in all the sciences.

Medical science, for example, no longer is content merely to cure disease. It realizes that the most efficient manner of ridding the world of plague is not by fighting it after it arrives but by keeping it from arriving. To this end it has developed sanitation and

hygiene, and in this respect your Association has been an outstanding leader. It cleans up our cities and keeps them clean, in order that pestilence may not breed. Working in its laboratories it develops anti-toxins which ward off, by granting immunity, such sporadic outbreaks of disease as do occur, after every means has been taken to prevent them from occurring. And, further, when disease does show its head it resorts immediately to isolation, to quarantine, in order to localize it and thus stamp it out quickly.

Today, in medicine, any other course would be unthinkable. Merely to rest content with attacking disease after it has developed would be much the same as shearing off the heads of weeds and allowing the roots to remain in the soil, from which new weeds can spring.

Fire is a kind of disease and must be eradicated by similar methods. Hence, whatever may be done to keep fire from starting is more basic, and in the end gives greater hope, than to fight it after it has started.

NECESSITY FOR PUBLIC EDUCATION

Now there are two broad ways in which the likelihood of fires starting may be reduced. The first of these is by public education. The people of America must be made fire-cautious. They must be taught to think in terms of caution. Their habits in dealing with all manner of devices, from the operation of a domestic furnace to the use of an electric pressing iron and the simple striking of a match; their habit, I say, in dealing with these and other things must be altered from the careless to the careful. They must learn wherein the dangers of fire lie and how these dangers may be avoided. Reduced to fundamentals it is a matter largely of group and regional psychology, of engendering the right attitude among the hundred and eighteen millions of people which make up our population.

Furthermore, they must be made to view every fire loss, no matter how small or where it occurs, as a loss which falls ultimately on their own shoulders. They must be taught to realize not only how to avoid it but why to avoid it. They must be shown that the matter of insurance, for instance, is quite beside the mark, since insurance companies are after all but agencies for collection and redistribution. When the American people understand the obvious fact that their fire losses are not paid for from the funds of an insurance company, any more than the checks they cash at a bank are drawn upon the

bank's own private capital, the fire loss in America will begin permanently to decline. All this has a very intimate bearing on the prevention of fire.

SAFE CONSTRUCTION

But there is a second manner of attacking fire before it starts. It is a more tangible method. It is the method of safe construction. Here we are dealing with hard facts. It does not require much more than a casual inspection to impress anybody with the fact that American cities, with very few exceptions, are haphazard aggregations. They were not laid out scientifically nor have they developed scientifically.

The average city in this country does not present as much regularity of design or lay out as a well planted onion patch. Like Topsy it just "growed up." Some geographical advantage, in the beginning, attracted a huddle of buildings at a particular point. From modest beginnings the population increased over the years, and so did the number of buildings, which strewed themselves about in a helter-skelter fashion. In this jumble almost anything that could boast of four walls and a roof to keep out the worst of the elements sufficed, so long as the town remained small, the people careful and life relatively simple.

But with the passage of time the town grew into a city, the people, no longer pioneers, lost the caution of the pioneer and life within their limits grew more complex. There came, too, the various conveniences of modern civilization, such as gas, electricity, central heating, and similar "softening" influences.

The old, rough methods of building were no longer suitable. They were dangerous and unsafe. Buildings so constructed were a constant menace not only to their occupants but they threatened the safety of neighboring structures. There were no accepted standards of safety by which to judge of a building. One man, having regard for the inmates of his building might use unburnable material, only to find that his next door neighbor had built of light frame, and to find that this, plus a highly inflammable roof served to expose his building to fire and render negative all his care. Moreover, the various types of industry were scattered promiscuously throughout the city. There was no attempt to segregate hazardous occupancies to keep them from exposing non-hazardous.

This, in brief, developed in a short time a situation wholly im-

possible. Something had to be done. Then came the Building Code, which set up within the community standards of right construction both as to materials and as to design. There came also zoning laws to restrict certain areas in the interest of future development which should be both harmonious and fire safe. Consideration, following the example of Europe which had learned its lesson earlier, began to be given to such matters as the enclosure of vertical openings—including stairways, elevator shafts, ventilating systems—after thousands of fires, and even conflagrations, were seen to have owned their proportions, their wide spread, to the interior draughts which such openings created. Attention began to be given also to the limitation of horizontal areas which, times without number, had enabled the flames to sweep laterally from one end of a building to another in the absence of any suitable cut-offs. Such things as fire doors and fire shutters were evolved and windows were set with wired glass instead of plain.

Not by any means universal is the employment even yet of these various means and devices for preventing spread of fire; but their use is growing daily and these, together with the prohibition of combustible roofings and the substitution of non-flammable for flammable structural materials constitutes the second method of preventing fires.

Most of this applies, however, to the future rather than to the past. Never are building codes or other laws sufficiently retroactive to alter at once and radically the existing complexion of a city. There is now, and there will continue to be for many, many years, a preponderance of poor construction. Only the passage of time—and a long time at that—will eliminate it in toto. Meanwhile there will continue to be outbreaks of the disease of fire which cannot be prevented. In short, while doing our utmost to keep fire from starting we must not neglect the need for extinguishing those blazes which do start. And this brings us to *Fire Protection.*

FIRE PROTECTION

Fire Protection again is to be considered in two broad divisions: Public and Private. And public fire protection in its turn, is separated into two branches: the fire department and the water supply. I shall not take the time to go into the operation of a municipal fire department. In the main, fire departments every-

where are trained and operated similarly, their ultimate function being to safeguard property from damage by fire and from the agencies employed in the extinguishment of fire.

Nor do I need to elaborate upon the use of water by the departments. For water, as nobody knows better than firemen and water-works men themselves, is, after all, fire's worst enemy. Science, in this present age, has provided many substitutes among the chemicals which serve in particular cases. But the oldest and surest extinguisher of them all is nature's own—water. It is the life-blood of every fire department. It is a kind of serum which, injected into a burning building, fights and eventually conquers the disease of fire.

It is rather with the use of water in connection with private fire protection that I wish to speak. I refer to the automatic sprinkler. There are three ways fundamentally in which a city's structures may be improved from the standpoint of fire-safety. One is to erect new buildings, with an eye definitely directed to freedom from fire. Another is to recondition old buildings, altering them so far as to enclose vertical openings and cut off excessive horizontal areas. And the third is to equip them with automatic sprinklers. Naturally, there also may be a combination of these three methods.

In every building there are two favorite starting places for fire. One of these is the attic and the other the cellar or basement. Although there are no statistics to show the percentage of blazes in business districts, for example, which originate below the first floor, the experience of most fire chiefs points to the fact that such blazes out-number all others in the proportion of at least two to one. For this there are very definite reasons. To begin with, the heating apparatus, with its tributary pipes, is located in the basement and this means the presence throughout many months of a so-called friendly fire, which through some untoward circumstance may readily turn hostile. Then, too, in all save a small percentage of the very tidiest buildings, there is an accumulation of rubbish and litter. Sometimes store-rooms are located in the basement wherein is collected a miscellany of old, discarded furniture and fixtures, most of it highly inflammable. Stock and shipping rooms, with vast quantities of paper scattered about, frequently are established in basements of business buildings. All in all, the basement is employed as a kind of service department in nearly every commercial structure. This means fire hazard.

Persuaded through unpleasant experience that this was the case, the city of Indianapolis recently conducted a campaign for the installation of sprinklers in the basements throughout its business district. The results were striking. According to the Indianapolis fire chief, the number of alarms for basement fires has been reduced to an almost infinitesimal amount and this within a comparatively short time. This proves that the basement hazard, at least in Indianapolis, was real and that cleanliness and the automatic sprinkler was the solution of the problem. Naturally there is no reason to suppose conditions elsewhere to be greatly dissimilar. What was done in and for the safety of Indianapolis can and should be done everywhere.

It is very much to the benefit of a city and its occupants to have its buildings sprinkled. Records kept over a long period of years have established the efficiency and reliability of the approved automatic sprinkler beyond dispute. Not only in basements but in every other part of business buildings, whether offices or stores, lofts or factories, they have proved their worth. The number of fires the automatic sprinkler has extinguished since the first one was installed is legion. No man could count them. They run, certainly, into the tens of thousands. It has failed, of course, now and then, but more often than not the failure has been due to poor installation or careless maintenance rather than to any inherent fault in the system. Hence, The National Board of Fire Underwriters stands with every other fire protection organization in strongly advocating the automatic sprinkler. Every sprinkler head installed in a city enhances, by so much, that city's safety from fire. Especially does it reduce the menace of conflagration.

It is obvious that the automatic action of sprinklers in controlling and extinguishing fires renders it less likely that the fire department will need to be called upon. Sprinklers work at a comparatively low pressure and use but little water. By controlling fires when they are small, they decrease the probability that the public water system will be called on to meet a heavy demand upon its capacity. Thus is the sprinkler system of definite benefit to the community.

Doubtless in these remarks I have covered ground which is at least as familiar to your feet as to mine. It may be, too, that I have said many things that seem to be almost primer-like in their obviousness. But I wanted to be sure that I told a clear, straightforward—though necessarily brief—story of the "fire situation" as

it is in America at this moment. And, finally, I wished to drive home this point about sprinkler protection, the part it has played and is playing now in combating fire loss.

As some of you know, I have been a water-works man myself. I know something of your problems, therefore, as well as the problems of the fire-fighter. I know them to be real problems in both cases, but I know them also to be solvable ones. And I know, further, that they must be solved if America is not to continue burning up her substance at the appalling present pace of $1064 a minute!

This, after all, is a situation which calls, and calls imperatively, for the exercise of public spirit on the part of everyone who realizes its seriousness. You, as water-works men, have that realization and you have also the requisite public spirit. That you will continue to do your full part, in waging the unending war against fire, in the future as you have in the past, I do not doubt.

THE UNDERWRITERS' ASSOCIATION AND WATER DEPARTMENTS[1]

By Lawrence Daw[2]

When our engineers visit a community to report upon the fire protection thereof, their first investigation is that of the water system and the following points are reviewed.

The preparation or correction to date of existing maps of the distribution and supply works, showing all mains, hydrants and valves. The importance of the maintenance of such maps by a water department cannot be too highly emphasized. In a number of the smaller communities we have found it necessary to go out in the field and check the memory of construction foremen where no recent records have been kept.

The best estimate possible should be made of the daily consumption, which, if not 100 per cent metered, or at least the supply works metered, we sometimes find extremely difficult, and can only be checked in some cases by taking flow tests on the supply main and working them against the theoretical lost head from the reservoir elevation, or in systems where the supply is pumped to the reservoir, by capacity and hours of operation of the pump.

The supply works themselves are then investigated as to their capacity, reliability and seasonal or other shortages. Types of hydrants and hose threads are investigated and recorded. On the latter subject we might state that we have now in progress the standardization of all possible hydrant and hose threads in New York State to an adaptability with the National Board Standard of $7\frac{1}{2}$ threads to the inch, $3\frac{1}{16}$-inch diameter, and are employing a trained mechanic with four sets of thread adapting tools who is now working in the eastern part of the state. Within any reasonable limits of 7 to 8 threads and 3 to $3\frac{1}{8}$-inches in diameter, all such couplings may be made to work with the National standard for hose, a valuable feature for the interchange of aid between communities.

[1] Presented before the New York Section meeting, October 27, 1927.

[2] Chief Engineer, Underwriters Association, Syracuse, N. Y.

Pressure and delivery tests are then made at well selected locations throughout the entire system, by reading the static pressure in the center of a group of hydrants, the latter then being opened and the flow measured by Pitot tubes, reduced to the required number of gallons for the class of property under consideration. These tests are carefully checked with theoretical flow which should be obtained at these points. They very often enable us to pick up closed valves or errors in the size of piping as recorded on obsolete maps, or sedimentation or obstruction of the distribution system in general.

As a result of the test, the quantity of water available at 20 pounds residual pressure is computed in cities and communities maintaining fire engines, although it is not our practice to draw down the pressure in the system to this figure.

We have found by these tests, in a number of cases especially in the small communities, that they are deceiving themselves as to the value of the fire protection, relying upon a high initial or starting pressure, whereas the flow tests show that only nominal protection may be had when the required quantity of water to deliver even two standard fire streams, or 500 gallons per minute, is being used.

When the investigation is completed we are always glad to forward to the water department or water company a complete copy of the test and our recommendations for such improvements in the water system as would result in the betterment of its grading and the consequent reduction of the basic rate of the community, upon which all individual insurance rates depend.

In the case of new water works installations in smaller villages we are very glad to coöperate with the engineer in charge and to go over the plan and make the theoretical figuring on the schedule. We can often show where, by slight changes, a considerable improvement in the system as far as fire protection goes may be had, with the consequent reduction in rate. One notable example was the case of a small village pumping from a spring supply. The tower tank was placed directly at or near the pumping station, and on the supply line to the village, whereas there was an equally suitable elevation at the further side of the village. Had it been placed there, so that the distribution would be between primary and secondary sources of supply, a reduction of not less than 10 per cent in the final grading would have been had.

I shall now refer briefly to the more important features of water supply, which are given primary consideration in the rating. These

are divided into 32 sub items, each of which is applied, generally speaking, on the ratio of quantities available to quantities required, with a possible total maximum deficiency of 1700 points. Consideration is, of course, given to methods of appointment and administration, to completeness of records and plans, to provisions for emergency repairs and to receipt of fire alarms at pump station or department offices, but the main features are the adequacy and reliability of the various parts of the supply works and distribution.

The required fire flow in the congested district is based primarily upon population and upon the general structural conditions and includes an allowance for loss in possible broken connections in a large fire. The average requirements are tabulated in the schedule and range from 1000 gallons per minute for 1000 population to 12,000 gallons per minute for 200,000 population. In order to avoid a deficiency, it is necessary that this fire flow, in conjunction with the maximum daily consumption, be available for a ten hour fire at not less than 20 pounds residual pressure, that is, at pressure suitable for engine supply.

The flow tests are usually made by taking simultaneous Pitot gauge readings on several hydrants while the residual pressures are noted at a hydrant near the center of the group. Ordinarily not enough water is drawn to lower the residual below say 40 pounds. With delivery taken in several steps in multiples of a standard 250-gallon stream, a fairly close approximation may be made of the probable fire flow at 20 pounds. These tests are made in two or more parts of the congested fire district to determine the effect of small mains, and deficiency is applied proportionately.

The unreliability of the supply at various seasons of the year may introduce a deficiency, although none is indicated by flow tests.

Direct pressure or combined systems are likely to be more unreliable than a purely gravity supply, unless sufficient storage and reserve units are maintained. There is no deficiency charged if, with the largest two units out of commission, the remaining pumps in connection with storage will furnish maximum consumption plus fire flow for a ten-hour period. This charge is also applied to low lift pumps or compressors, if any, and to generators if pumps are electrically driven.

Pumping systems may be also subject to charge for lack of reserve boilers, insufficient coal, gas or oil supply, single steam line to pumps, and single or unreliable electric transmission line.

Pumping stations are not charged if fireproof, sprinklered or otherwise properly protected, unexposed, sections cut off by fire walls and internal hazards of light, heat, and power, safeguarded.

One of the most important features of reliability is the duplication of supply mains. The worst possible single break, whether in suction line, pump discharge or header, force main, filter piping, or distribution, is considered, and deficiency applied on the basis of what is then available in proportion to required fire flow and maximum consumption, giving credit for reservoir storage. Supply mains should be reliably installed, of course, with proper cross connections, blow offs, air valves, and check valves, and protected from physical damage.

It is necessary that good sized arteries and secondary feeders extend throughout the system. Tests made over the entire city give an indication of the adequacy of the secondaries. Charge is made for 4-inch and smaller pipe, and for 6- and 4-inch dead ends in proportion to the total length of the distribution system. In closely built residential sections cross ties should be at least 8 inches and maximum block lengths of gridiron 600 feet. These last three charges are somewhat modified by the average normal static pressure and by fire engine response.

Pipe in the distribution system should be reliable and of the proper class to withstand the head obtaining. As a general thing cement lined and wood pipe are charged for, as are also conditions favorable to electrolysis.

Gate valves should be so spaced that in case of break it will not be necessary to cut out of service more than 500 feet in high value districts, nor more than 800 feet in other districts. Periodic inspections are advisable and all valves should operate in same direction. Fire flow tests sometimes prove that valves opening in opposite direction have been unintentionally left closed.

Hydrant distribution depends upon the required fire flow as determined from a tabulation in the schedule. This varies from 120,000 square feet for 1000 gallons per minute to 40,000 square feet for 12,000 gallons per minute with a lesser area, if no engines are provided. In any case it is best to have two at each street intersection in the high value district and at least one midway of the average block.

Where the distribution system also extends through alleyways, hydrants are very valuable for back fighting, especially in compactly built blocks.

Semi-annual inspections, at least, are necessary. Tests often reveal leaks, stones in the barrel, different sized top nuts, and sediment in the mains. This last has sometimes plugged the Pitot tubes and on one occasion it was necessary to shut down the entire distribution system for two hours to remove a hydrant, which was not gated on the lateral and whose valve was blocked by a large stone.

All hydrants should be gated on 6-inch connection to street main. They should have at least two $2\frac{1}{2}$-inch hose outlets and also a large steamer connection where use of fire engine is necessary. Barrel should preferably be not less than 6-inch and, if accidentally broken off, valve should remain closed.

The foregoing comprise the essential features which have to do with the grading of the water system and its effect upon the consequent key rate of the community, but in practically all cases they are so interwoven and interrelated with the fire department and structural conditions of the community, that a number of involved calculations are necessary to produce the final grading. It would be almost impossible for a water department or a company to attempt to figure the resulting final effect of any individual improvements. If they are submitted to us in such cases we shall be glad to undertake all the necessary work and give to those authorized, as nearly as possible, accurate and definite information.

COMPENSATION OF EXECUTIVE AND TECHNICAL FORCES IN WATER WORKS AND OTHER UTILITIES[1]

By William W. Brush[2]

This subject is one that comes very close home to many members of the American Water Works Association and interests thousands of those who are employed in the water works field. The writer was requested to investigate the relative rate of compensation of the force employed in water works systems and in other public utilities. To secure data from all sections of the United States and from cities of varying size a short questionnaire was sent to men representing 70 communities; 45 replies were received and the more important information given is set forth in table 1.

As the letter accompanying the questionnaire promised that the answer would be confidential as to the identity of the community involved, the table has been prepared to avoid revealing the places reported, but they represent all sections of the United States. The replies received showed that a comparison between salaries received in the water works field and in other public utilities would be impossible due to the lack of information available. In the few cases where such information was given, the salaries did not vary materially if the other utilities were also under municipal control. In private companies the salaries were about double for the electric and gas companies, and generally decidedly higher for the private water works systems.

It is believed that enough data have been secured to form a basis for a helpful discussion of this important subject of compensation of executives. No effort has been made to include the men other than the chief executive as the impossibility of setting forth the compara-

[1] Presented before the Plant Management and Operation Division, Chicago Convention, June 8, 1927.

[2] Chief Engineer of Water Supply, Department of Water Supply, Gas and Electricity, New York, N. Y.

tive duties and salaries of the assistants is obvious. The arguments made hereafter will, however, generally apply to all the executive and technical forces.

WHAT ARE THE EXISTING CONDITIONS?

Unrest and dissatisfaction with the monetary return in the water works field is virtually universal, especially in municipal systems. Those who have been long in the service have found it necessary to revise downward their standard of living for themselves and their families and many have taken up night and Sunday work to help meet expenses. The low salaries offered do not attract into the field the men with suitable training and ability and the service seriously suffers.

TABLE 1

Salaries of executives

POPULATION SUPPLIED	PRESENT AVERAGE SALARY OF MANAGERS OF WATER WORKS, DOLLARS	EQUIVALENT SALARY IN PRE-WAR DOLLARS*
15,000 to 25,000	4,350	2,610
25,000 to 50,000	4,075	2,445
50,000 to 75,000	4,140	2,484
75,000 to 100,000	3,460	2,076
100,000 to 200,000	5,450	3,270
200,000 to 350,000	5,521	3,313
350,000 to 500,000	7,075	4,245
500,000 to 1,000,000	6,000	3,600
Over 1,000,000	9,375	5,625

* The present dollar is assumed to average $0.60 in its purchasing power when compared with the pre-war dollar.

Unfortunately, this situation is not known to many of those who are served by the water systems and its effect is not clearly recognized.

The questionnaire shows that there are men responsible for the water supply of nearly 100,000 persons who are receiving as little as $2,000 per annum. This amount is equivalent to $1,200 before the World War. Until one reaches cities of over 100,000 population, the average compensation is about $4,000. For this salary it will be impossible to secure men who have the technical knowledge, fidelity to duty, and executive ability to safely and successfully

maintain and operate a water system to supply to 100,000 or more people, a pure, satisfactory water supply.

If we compare the salaries paid with the compensation of men in the labor class we find startling results. The lowest salary given of $2,000 is less than is paid to many unskilled laborers and helpers today, who have no responsibility and only do what they are directed to perform. A bricklayer in the service of the City of New York who works six days a week will receive more than the borough engineer in charge of the water supply system for 150,000 people and nearly as much as the borough engineer in charge of the supply for about 1,000,000 people. These statements do not indicate that skilled labor is receiving too much, but that the salaried executive is receiving too little.

If the compensation had remained relatively equal to that received before the World War, there would still be cause for complaint as the cities have grown by leaps and bounds and by such growth have added to the work of the water supply force. To see one's work increase and one's compensation diminish will disturb and discourage any man.

WHAT ARE THE MAIN CAUSES FOR THE PRESENT UNSATISFACTORY CONDITIONS?

The primary causes are the reduction in the purchasing power of the dollar, the refusal of communities to recognize this fact, and to adjust municipal salaries accordingly. The water works executive and technical forces note the general increase in wealth in the community and the lowering of their standing in the financial scale. As year after year passes and the water works employe and his family find it increasingly difficult to continue to live in a manner reasonably consistent with his former position in the community, his resentment against the injustice imposed on his family increases and he naturally more strongly and frequently voices his feelings. The stoppage of engineering work here in Chicago as a protest is an unusual illustration of this condition. The most serious result to the community is the practical elimination of the college or otherwise suitably trained man as a candidate for the positions in the water works maintenance and operating field.

WHAT IS THE REMEDY?

This question is one of those more easily propounded than answered and no unanimity of opinion can be expected. The writer's suggestions are as follows:

1. Present to public officials and to all who can be interested the danger to the community and its financial loss, if through inadequate compensation an adequately trained force for the water system cannot be secured and thereafter held.
2. Set up through the American Water Works Association a schedule of compensation that is reasonably required to secure competent men and through the secretary call to the attention of city officials and others, the unreasonably low compensation paid to the water works force when such is the case.
3. Interest civic associations in the subject and secure their aid in in rectifying the existing conditions.
4. Endeavor in every reasonable way to advance the compensation of subordinates to the figure at which a competent substitute could be readily secured, realizing that the more competent the subordinate is and the more adequate his rate of pay, the more surely will the inadequacy of the compensation of the manager or chief executive be recognized.

CENTRIFUGALLY CAST CONCRETE HIGH PRESSURE PIPE FOR RIVERSIDE[1]

By Edward R. Bowen[2]

The factors controlling the design of the Riverside main water supply conduit left only 15 feet of head available for friction and other losses in a distance of 42,000 feet under a maximum delivery of 20 second feet. The average hydraulic gradient is 0.35 feet in 1000 feet.

With these small friction losses available, it was realized that a pipe line of good alignment and extremely smooth interior surface was necessary to meet the hydraulic conditions. Not only was it necessary to obtain these conditions at the time the pipe line was installed, but they must also be maintained throughout the life of the pipe, inasmuch as a demand for its total capacity would probably not accrue for a period of twenty to twenty-five years.

It was highly desirable also to obtain a long lived structure.

In the speaker's judgment, a concrete pipe line best met these conditions and the development of the centrifugally cast concrete pipe in this district within the last year or two appeared opportune, as the quality of this product was, in my judgment, far superior to any other concrete pipe with which I am familiar.

The diameter of the line is based upon the Scobey coefficient of 0.345 in the Scobey formula $V = CH^{0.5}d^{0.625}$. The Scobey coefficient adopted corresponds to a $C = 120$ in the Williams and Hazen formula, and to N in the Kutter formula of 0.012 for pipes up to 24 inches in diameter and 0.013 for pipes greater than 24 inches in diameter.

SCOBEY TEST

The installation is completed and has been put in service during the past month. Inasmuch as there are no technical data available upon the flow of water in pipe lines of this character, the Board of Public Utilities of the City of Riverside communicated with Fred C. Scobey, Senior Irrigation Engineer of the United States Depart-

[1] Presented before the California Section meeting, October 6, 1927.

[2] Consulting Engineer, Los Angeles, Calif.

ment of Agriculture, and requested that the pipe line be studied with the view of making available technical data bearing upon the capacity of pipe lines of the particular type. Mr. Scobey, as you know, is an authority upon this subject and has published several bulletins of the United States Department of Agriculture dealing with the flow of water in pipes and canals of various character.

Following this request, Mr. Scobey spent practically six days last week in testing the flow of the Riverside pipe under varying conditions. The water was measured over a 5-foot weir at the intake of the pipe line and the pressure losses were determined by Mercury manometers at three places along the pipe. The manometers were attached through corporation cocks which were installed at the time the pipe line was constructed and made flush with the interior of the pipe. Any minor vibrations at the corporation cock were minimized by ordinary piezometer tubes in 3-inch pipe nipples attached to the corporation cocks. These piezometer tubes had four $\frac{1}{16}$-inch holes which would reflect pressure head only, the object being to secure net pressure rather than velocity heads. The manometers were engine graduated to one-hundredth of a foot and readings were taken to one-thousandths. The basic plane was established by static conditions of the pipe line and afforded a perfect datum to work upon.

Although a final analysis of the data assembled by Mr. Scobey will not be available for some time, preliminary figures indicate that the pipe line as constructed will operate with a coefficient of from 0.370 to 0.385 in the Scobey formula, which is equivalent to a value of C in the Williams-Hazen formula of nearly 140.

The maximum flows available at this time are not sufficient to test the pipe line under maximum carrying conditions, and the highest velocity now obtainable is only about 2 feet per second. The tested velocities are so low and the friction losses so small that any experimental errors are a much greater proportion of the total loss of head than they would be if greater velocities were possible. We appreciate that the results obtained are tentative and subject to verification by other tests on this particular type of concrete pipe.

HUME CENTRIFUGAL PIPE

The Hume centrifugal pipe comes to us from the patentees, the Hume Brothers of Adelaide, Australia. The process has been used with success during the last six or eight years in Australia, South

Africa and England. There are several thousand miles of pressure line work installed in Australia, some of which is as large as 72 inches in diameter.

This pipe is now being fabricated in Southern California by two manufacturers, the Bent Concrete Pipe Company and the Western Concrete Pipe Company.

The major installations in California are the construction of about 17,000 feet of 18- and 27-inch diameter pipe for the Laguna Beach Water District, the construction of about 10,000 feet of 18-inch pipe in the City of Beverly Hills, and the installation at Riverside comprising about 42,000 feet of 42-inch diameter pipe operating under heads up to 105 feet. These lines were built by the Western Concrete Pipe Company.

RIVERSIDE PIPE

The Riverside line is in general an inverted syphon with seven summits. It is divided into four sections by 36-inch main line gates. These gates include 6-foot steel tapered sections on either side. Four inch Simplex air and vacuum valves were installed on each side of the main line gates and at all summits. The pipe is equipped with blowoffs or drain valves at all sags or low places in the line. Manways are left in the pipe at approximately 1000-foot intervals and pressure outlets were attached where necessary. The manways and outlets were fastened on as saddles clamped to the pipe and bedded in concrete.

SPECIFICATIONS

The specifications for the fabrication of the Riverside pipe were drawn in a rather broad manner, it being the intention to specify the results desired rather than the method of obtaining them. The proportion of the aggregate and the cement were specified for a minimum cement content, it being left to the discretion of the manufacturer to vary the proportions for the best results. The proportions actually used averaged 1 part of cement to 2 parts of sand to 1.1 parts of stone. They varied somewhat with the aggregates and the pressures to which the pipe was to be subjected.

The reinforcement consisted of No. 8 gauge black annealed wire proportioned to withstand the entire internal pressure on the pipe at a unit stress of 16,000 pounds, neglecting the tensile strength of the concrete.

The tolerance in the dimensions of the pipe were $\frac{3}{8}$-inch variation from a true circle or $\frac{1}{4}$-inch under the 42-inch diameter.

The specifications provided for curing under low temperature steam for at least twelve hours before the forms were removed, and storage under sprinklers for six days, the first three days being under burlap. No pipe was removed from the yard until it was fourteen days old.

TESTS

Yard tests for both internal pressure and external load were specified.

One length of pipe out of every 25, selected at random, was tested under hydrostatic pressure to 120 per cent of the working pressure to which the pipe would be subjected, but all pipe must withstand a pressure of not less than 25 pounds. To pass the test successfully the pipe must show no cracks and have no noticeable seepage. One length of pipe out of every 100 lengths was tested for external pressure by supporting the lower one-fourth of the circumference in a uniform bed and loading uniformly the upper one-fourth of the circumference. The pipe should successfully withstand an external load of 4,000 pounds per lineal foot and failure was deemed to have occurred when the pipe showed a clearly visible crack. No pipe failed to pass the yard tests.

A field test provided that the pipe line was to be subjected to 150 per cent of the maximum working pressure for a period of 4 consecutive hours. The leakage under this test should not exceed 200 gallons per inch of diameter per mile of pipe per 24 hours.

This test was made on about 35,000 feet of line and resulted in a leakage of only 17 per cent of that allowable. The result of this test, together with the fact that there was not a single bad joint developed in the entire installation, leads to the conclusion that the methods adopted for the joint construction and installation are well advised and successful.

FABRICATION AND CONSTRUCTION

The process of fabrication consists of placing the mixed concrete materials in steel forms mounted upon driving drums and rotated with a variable peripheral speed. The forms are rotated during the time the concrete is being placed at a speed sufficient to insure a uniform distribution of the aggregates throughout the wall of the

pipe under the centrifugual force. After the form contains sufficient concrete to give the required shell thickness, the peripheral speed is increased to about 2,100 feet per minute and continued for a period of 8 to 15 minutes according to weather and other working conditions. Spinning is then stopped and the excess water, latents, bits of wood or other foreign materials are brushed from the inside surface. The pipe is then respun for a few minutes and a smooth interiors urface is produced by burnishing with a steel rod and leather trowels.

The sections of the Riverside pipe are 42 inches inside diameter, 8 feet long and have a shell thickness of $3\frac{3}{4}$ inches. They are reinforced for pressure equivalent to heads of 50, 75, 93 and 105 feet. The sections are joined together in the field, the male and female ends of the pipe making a self-centering joint. The collar is caulked to the female end in the yard with a dry mix of neat cement, in the same manner as a cement joint in a cast iron pipe is formed. Particular pains were taken to see that this caulking was driven up hard. When the pipe is placed in the ditch, the alignment is carefully checked and just enough cement mortar is placed on the inside of the pipe to seal it. Rope packing is then placed around the pipe at the exterior of the open end of the collar and the backfill is brought up over the pipe. A liquid grout is then poured into the annular space through a long nozzled funnel down one side of the pipe until it flows out from the opposite side. The ditch is next water settled. The inside of the joint is subsequently pointed with cement mortar, care being taken to equalize over a distance of 6 or 8 inches any inequalities in the centering of the pipe. The result of this practice is to provide an interior barrel which is true to line and extremely free from waviness.

In my judgment, the success of the field joints is due to the fact that the pointing on the inside of the pipe was done after the line had been backfilled and the ditch water settled. The pipe was not then subjected to stresses resulting from wide temperature variations between night and day. As soon as practicable after the section of the line had been completed, an inspection was made on the inside of the pipe. Any hair cracks were readily discernible and were cut out and repointed before water was turned in.

Tests on the concrete from the mixer show about $\frac{3}{4}$ inch slump. With this in mind, it is startling to see the volume of water expelled in the spinning. Whereas the best poured concrete will weigh about 145 pounds per cubic foot, the centrifugally cast concrete will weigh

from 160 to 165 pounds per cubic foot. Tests show from $3\frac{1}{2}$ to $4\frac{1}{2}$ per cent absorption. This of course is a measure of its density.

The wire reinforcing cages are accurately made by machine and are wound under tension. The centrifugal force under which the pipe is made not only insures the concentric placing of the steel, but also induces a slight initial tension. Packing the concrete around the steel under the centrifugal force probably adds to the bonding strength. The use of small wires distributes the steel uniformly throughout the pipe and gives a materially larger ratio of bonding area to cross sectional area of steel than where bars or rods are used.

DISCUSSION

A MEMBER: As compared with ordinary reinforced concrete pipe, what is the cost?

EDWARD R. BOWEN:[2] The cost of the pipe is slightly greater than ordinary reinforced concrete pipe. It is difficult to give any definite idea because in concrete pipe the availability of the materials and hauling conditions may make wide variations in costs.

A MEMBER: What about breakage losses in laying the line?

EDWARD R. BOWEN:[2] We had about 42,000 feet of line and about 300 feet of pipe were left over after we were all through. I should judge about one-half of the 300 feet were cull sections. It is surprizing how little breakage there was. Of course, occasionally we drop one from a truck.

A MEMBER: Did you lay any on curvature?

EDWARD R. BOWEN:[2] Yes. The line is laid out on the basis of standard curves; most of the curves being on a 500 foot radius and some on a 100 foot radius.

You can lay with the 500 foot radius without any modification of the section at all. On the 100 foot radius we have a bevelled end; we simply put a bevelled ring in the end of the pipe forms before spinning the section.

Curves of shorter radii are constructed with short sections of pipe with beveled ends. The sections are two feet or more in length so that almost any degree of curvature may be obtained.

A MEMBER: How do you take care of expansion and contraction on the line?

EDWARD R. BOWEN:[2] The undersurface of the ring or collar is made rough when cast, and the exterior of the pipe is very smooth; so that if there is expansion, there may be some movement at the joint.

This movement could be expedited by painting the outside of the pipe with graphite or some other lubricant.

We have one section of pipe about 120 feet in length which was built on piers above the ground. When water was first put into this section of the pipe, it leaked to some extent at the joints. Leaks, almost without exception, were at the bottom part of the joint. They may have been due to a slight settlement in the piers which would tend to pull the pipe apart at that point. The leaks were all drip leaks and have since taken up.

A MEMBER: Has this pipe been made for materially higher pressures than you spoke of?

EDWARD R. BOWEN:[2] I cannot answer that question directly. We have tested some of the sections of our pipe in the yard to destruction and have found out what it will do.

Two sections of 50 inch head pipe were selected at random. One section was tested to failure which occurred at a hydrostatic pressure of 84 pounds per square inch, and consisted of one crack about 4 inches long near the end. The second section was tested to 60 pounds pressure for a period of 40 minutes without any signs of failure. This section was held until it had reached an age of 28 days when it was tested to destruction and failed under a pressure of 97 pounds per square inch, failure consisting of three small longitudinal cracks, two in one end and one in the other.

Similar tests were made on sections of pipe designed for higher heads, the results of which were about the same.

It was found that the pipes in which failure had occurred when tested under lower pressures remained tight.

Fred C. Scobey:[3] Some of you may be familiar with our papers on the carrying capacity of pipes for general purposes. We have published bulletins on the flow of water in wood-stave and concrete pipes, and will soon have another on the flow of water in riveted steel and analogous pipes.

When it was suggested that tests be made on the Riverside line, just described by Mr. Bowen, I was very glad to coöperate with the City of Riverside as there were no tests of which I am aware on the flow of water in centrifugally-cast concrete pipe. Some months prior to the tests we made careful measurements of two diameters on many random joints of the pipe as it lay in the yard; thus we had absolute data on the pipe size.

The loss of head was determined with mercury columns in glass tubes that were engine-divided so that readings within 0.001 foot were perfectly feasible. Three gages were set up and the static pressure-readings of the mercury columns were made while the water was standing in the pipe; that is, there was no loss of head as there was no velocity of flow. From these base readings the proper loss of head for each flow could be easily computed from the average readings of the mercury columns. The first two gages were at the ends of a reach some 5 miles long which contained about 500 degrees of curvature and all "specials." Between the second and third gages there was some 6,000 feet of perfectly straight pipe. Our final computations will show the loss of head in straight pipe and as modified by the curvature.

As we approach the perfect pipe with a surface, say, equal to that of plate glass, we find that the very least difference in surface makes an appreciable difference in capacity. The same thing is noticed in the smoother of the concrete-lined open channels. As the object of a pipe is to carry water, then the relative capacity is a true measure of the pipe, and this fact should enter the specifications under which bids are submitted for all types of pipe work. This seems to me a legitimate and proper item. Such a difference was considered in the bids for the recent lines laid at Washington, D. C., at St. Louis, and for the East Bay Municipal District in California. I believe this practice will become general in the near future, as there is a vast difference in the carrying capacity of pipe lines.

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In closing I would like to point out the great improvement in the capacity of concrete lines. The present pipes of the best construction—such as the Denver and Tulsa lines and this one under discussion at Riverside—show a capacity nearly 50 per cent better, size for size and slope for slope, than the hand-mixed concrete pipe laid without smoothing the joints, during the early eighties, in Southern California. We now know that a general table for the capacity of "pipes" means nothing at all; we must know the material and the type of construction as well.

A CYANIDE CITRATE POUR PLATE MEDIUM FOR DIRECT DETERMINATION OF THE COLON-AEROGENES CONTENT OF WATER AND SEWAGE

By Ralph E. Noble[1]

SUMMARY

1. There has been developed a cyanide citrate pour plate medium which can be utilized for direct determination of the colon-aerogenes content of water and sewage.

2. With this medium the Bacterium coli index of water or sewage may be obtained in forty-two to forty-eight hours, whereas the minimum of time required by the present standard method is three to four days. This represents a saving of 41 to 50 per cent in the time required.

3. The index so obtained represents a nearer approach to the actual density of the organisms present in the sample tested than does that obtained by the lactose broth tube method now in general use. The new method also gives numerical results equal to or exceeding those of the lactose broth method in approximately 76.7 per cent of 1051 examinations.[2] The samples examined represent waters of a wide range of bacterial quality.

4. Not only may the colon-aerogenes group of organisms in water or sewage be counted directly, but the type of organism, namely, the fecal and aerogenes types, as defined by the methyl red Voges-Proskauer tests, is indicated in the medium with a reasonable degree of accuracy. In so far as is known, the only procedure now affording all this information requires seven to eight days, the more time-consuming step being the determination of the methyl red Voges-Proskauer reactions.

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[2] Plate indices equal tube indices in approximately 29.7 per cent of the observations. Plate indices exceed tube indices in approximately 47.0 per cent of the observations. Plate indices equal or exceed tube indices in approximately 76.7 per cent of the observations.

5. The accuracy of the Bacterium coli index by this plate method is considered dependable, and is believed to be comparable with that furnished by a plain nutrient agar plate. It is superior to that obtained by the lactose broth method and at the same time the mathematical difficulties involved in the latter are avoided. The lactose fermentation tube permits the growth of gas-forming organisms other than those of the colon-aerogenes group, which frequently results in pseudo-presumptive tests. In the end, the fermentation test may yield only a fecal type or only a grain type, when actually both types were present at the outset. The growth inhibiting properties of the new medium as developed at this time are believed to be negligible in view of comparisons made with plain nutrient agar.

6. The cyanide-citrate pour plate method of enumerating colon-aerogenes organisms is a practicable one for routine laboratory use and requires only the usual standard equipment. From the standpoint of economy, the method yields this information in a relatively short time period contrasted with the time and labor now required to obtain it.

7. The method meets a present need of sanitarians.

EXPERIMENTAL WORK

Theoretical considerations

There have been many attempts, with varying degrees of success, to produce solid media for the isolation of the colon-aerogenes group of organisms. Levine (1) summarizes those efforts which have thus far been made to perfect such a method.

Utilizing the principles demonstrated by Ayers and Rupp (1918) (2), Koser (1923) (3, 4, 5) and Muller (1922) (6) there has been developed in our laboratory a differential pour plate medium, essentially a modified Ayers-Rupp medium, which is suitable for the direct enumeration of colon-aerogenes colonies. The medium developed by us differs from that of Ayers and Rupp in that it contains two new ingredients, viz., ferric citrate and potassium ferrocyanide. For convenience, hereinafter, it will be referred to as the "cyanide citrate medium."

It may be well to recall that, in producing their synthetic medium, Ayers and Rupp demonstrated the principle that selectivity toward the growth of colon organisms could be produced in media by restricting the source of nitrogen to sodium ammonium phosphate and

the source of carbon to lactose. This is in marked contrast to the principle of inhibition of growth of non-colon organisms utilized in other differential media, such as the lactose bile of Jackson (1906, 1907) (7, 8) or the brilliant green lactose bile of Muer and Harris (1920) (9) or the gentian violet broth of Hall and Ellefson (1918) (10) or Endo's medium. Koser showed the existence of an intermediate colon organism, using citrate liquid (synthetic) and citrate solid (nutrient) media and thus contributed a new method of type differentiation. Muller successfully accomplished differentiation between the typhoid and colon-aerogenes organisms by means of a cyanide-tartrate solid (nutrient) medium for contrasting the surface growth on the same plate streaked with suspected material or incubated cultures.

At this point we should not overlook the theoretical consideration of the probable, though perhaps negligible, inhibitory influence of the dye and sulphite concentrations in the Ayers-Rupp medium or the probable introduction, with the inoculant, of nitrogen and carbon in forms available to bacteria, even though the quantity so introduced be comparatively small. Definite information on this point is lacking.

In undertaking this work, it was thought probable that a synthetic solid medium could be made, incorporating the principles of selectivity together with the least degree of inhibition practicable and thus avoid some of the practical objections now applying to the standard presumptive lactose tube method.

Preliminary experimental work indicated the optimum ratio and concentration of ingredients to be used in the cyanide citrate medium and these are here given, together with the analytical procedure worked out for the direct enumeration of the colon-aerogenes organisms of water and sewage by the cyanide citrate pour plate method.

Stock agar, per liter, $1\frac{1}{2}$ times the required strength:

Distilled water	1000.0 cc.
Agar (shredded)	30.0 grams
Sodium ammonium phosphate, C.P.	3.0 grams
Acid potassium phosphate, C.P.	1.5 grams

Stock solutions:

20.0 per cent lactose, C.P.

20.0 per cent potassium ferro cyanide, C.P.

2.5 per cent ferric citrate

Fresh solutions:

10.0 per cent fuchsin aqueous basic from a saturated alcoholic (95.0 per cent) solution
5.0 per cent sodium sulphite anhydrous
Sterile distilled water

Stock agar. It should be recalled that Ayers, Mudge and Rupp (11) have shown that the productive efficiency of washed agar is superior to that of unwashed agar. Some preliminary study of agar efficiency led us to the conclusion that for the cyanide citrate medium a four-day washed agar, prepared with a minimum loss of time to keep down the period of heat exposure, gave an optimum product. Shorter washing periods seemingly failed to remove adequately those salts probably of magnesium and calcium, which at certain concentrations appear to exert a depressing effect on production. A longer washing period seemed to reduce the congealing properties of the agar.

Preparation of the medium

To make 1 liter of the final stock agar $1\frac{1}{2}$ times the required strength, 30 grams of agar are soaked in 2000 cc. of distilled water for twenty-four hours, thoroughly agitated, drained and another 2000 cc. of distilled water added to the residue. This is repeated until the end of the fourth twenty-four hour period when the batch may be adjusted with fresh distilled water to make a 3 per cent agar for stock or for the 2 per cent agar and water "cover," or both, as needed.

Stock. The 3 per cent agar and water are melted in an autoclave or pot and the loss by evaporation corrected. The sodium ammonium phosphate is added and well mixed. Next the acid potassium phosphate is added, mixed well, and filtered; the reaction is adjusted to pH 7.0, and the medium is placed in convenient sized presterilized, plugged containers by means of a sterile graduate. These are then sterilized in the Arnold steamer for fifteen minutes only. It is advisable so to plan the schedule that each step may proceed rapidly without interruption, in order that the stock may be subjected to heat for the minimum time possible. The completed product should be of light opalescent or dark grey appearance. Unnecessarily prolonged heating may cause subsequent flocculation, which is undesirable from a counting standpoint and probably also affects the productive efficiency. Occasionally an impurity in a supply of commercial agar may also account for an "off-color."

Agar and water for "cover." The 2 per cent agar and water are melted, filtered, and placed in presterilized, plugged containers in convenient quantities by means of a sterile graduate; then autoclaved fifteen minutes at 15 pounds only.

Twenty per cent lactose, C. P. The lactose solution is sterilized by the method giving the least decomposition of the sugar, compatible with adequate sterilization.

Twenty per cent potassium ferro cyanide, C.P. The potassium ferrocyanide is mortarized, carefully weighed, and the solution heated in the Arnold sterilizer for fifteen minutes only. Weighing should be done accurately since slight deviations may alter the productive efficiency of the medium.

Two and one-half per cent ferric citrate. The ferric citrate solution is prepared in the same way as the 20.0 per cent potassium ferro cyanide.

The cyanide and citrate solutions are sterilized according to the suggestion of Muller. More intense heating tends to cause chemical decomposition.

Ten per cent aqueous solution of basic fuchsin (saturated alcoholic 95.0 per cent) is prepared and a *5.0 per cent solution of anhydrous sodium sulphite* is boiled and cooled before using.

It is preferable to store the agar and solutions at low temperature.

Analytical procedure

On the basis of using 20 cc. of cyanide citrate stock agar and 10 cc. of 2 per cent agar and water for a "cover" per plate, there is melted the estimated quantity of both required to plant the given number of samples. For each 100 cc. of cyanide citrate agar needed, the following "mix" is prepared:

	cc.
20.0 per cent lactose, C.P.	3.750
10.0 per cent aqueous solution from a saturated alcoholic (95 per cent) basic fuchsin	0.750
5.0 per cent anhydrous sodium sulphite, C.P. fresh	0.821
20.0 per cent potassium ferro cyanide, C.P.	3.571
Total	8.892

Add the "mix" to the melted stock in the proportion indicated. Thoroughly agitate to assure complete mixture. Add 3.571 cc. of 2.5 per cent ferric citrate and mix thoroughly. Clean burettes may be used advantageously for delivery of the "mix" and the citrate. *Caution:* Always add the citrate *after* the cyanide mixture has been added and thoroughly incorporated. It is of advantage to keep the containers of cyanide citrate agar ready for use in a water bath of 55° to 60°C. until just before use.

To those plates which will receive 1.0 cc. or less of inoculant, 10 cc. of sterile distilled water are added. Portions of 10 cc. or more are added without dilution. Twenty cubic centimeters of cyanide citrate agar, cooled, are then added to each plate and immediately mixed thoroughly. This is accomplished easily by a slight lifting of the cover during the usual plate agitation. After the poured plates have hardened each is poured with about 10 cc. of 2 per cent agar and water. This prevents surface growth which might obscure a subsurface colony and facilitates the differentiation of those colonies which would otherwise appear as surface growth. Invert the plates in the 37°C. incubator for 42–48 hours.

The plates are counted with transmitted light afforded by the standard counting frame with a white background and illuminated from the sides.

Colonies of the colon-aerogenes group usually appear in marked contrast to any extraneous forms which may occur. The former are small pink or brick red colonies. In general, the fecal types appear as small black or dark red discs or as triangular forms having an approximate diameter of 0.5 mm. The extremes may range from 0.25 to 0.75 mm. in diameter. In general, the grain types are usually pink, black (blue by reflected light), colorless or black sided discs with diameters ranging from approximately 0.5 to 4.0 mm.

The method here described makes feasible the planting of a single 50 or 100 cc. portion in lieu of the conventional five 10 cc. portions, and thus obviates the present necessity of accepting an index per 100 cc. computed from 10 cc. portions. The index thus afforded is more reliable because it does not include the error inherent in the use of multiple portions. To plant these larger portions, however, requires a modification in equipment, namely, the use of sufficiently large plates, adequate volume pipettes, and perhaps the enlargement of the orifice of the counting frame. If large volumes are plated it will be found more satisfactory to use plates of a diameter sufficient to avoid too great depth of total contents which would render counting difficult by obscuring the deeper colonies.

The cyanide citrate plates should be counted after forty-two to forty-eight hours of incubation, since incubation for sixty hours permits the advancement of certain other forms which take on an appearance similar to that of certain colon-aerogenes types. When necessary, however, plates may be stored at low temperature over night, then counted with a dependable degree of accuracy.

The productive efficiency

To ascertain the efficiency of the medium, its ability to support the growth of Bacterium coli was compared with that of plain nutrient agar.

In the preliminary study of the medium with variable amounts of the cyanide and citrate ingredients, the productive efficiency was determined by comparing mean counts obtained on the medium under test with a plain nutrient agar moving mean titre, expressed in per cent of the total number of organisms growing on the latter medium. Moving mean titres were established by taking the differ-

ence between the mean plain agar counts at the outset of the experiment and the mean of those at the end, and prorating this difference over the entire test series. This is illustrated below:

INITIAL COUNT	REFERENCE POINTS				END COUNT
	1	2	3	4	
100	98	96	94	92	90

This method seems to be more accurate than to use the single initial titre, especially when the planting period is appreciably long. Data thus obtained with a single strain each of fecal, grain and intermediate[3] types, tended to establish the optimum ratio and concentration of the variable ingredients and made possible a comparison of the productive efficiency of the medium with that of plain agar.

TABLE 1

Distribution of negative results over the steps in the standard method procedure of colon group determination

PRESUMPTIVE TEST NEGATIVE	PRESUMPTIVE TEST POSITIVE ENDO OR E.M.B. PLATES NEGATIVE	ENDO OR E.M.B. PLATES NEGATIVE SECOND GAS NEGATIVE
13	4	10

In general, the productivity of the new medium was found, in a series of 14 observations, to range from 90.2 to 118.9 per cent of that of plain agar, averaging approximately 104.6 per cent. The variation in the ratio and concentration of the ingredients as reflected in the results brought out the fact that production is most sensitive to the cyanide, citrate, fuchsin and sulphite and to the first two more than to the latter two.

Confirmation of colonies isolated from cyanide citrate medium

Concerning the dependability of the cyanide citrate plate method in identifying colon-aerogenes colonies, data at hand permit us to state conservatively that the method gives a high degree of accuracy. Four hundred and four colonies picked from the special medium were confirmed according to the standard procedure by lactose broth

[3] Methyl red positive, Voges-Proskauer positive.

fermentation, growth on Endo's medium and eosin methylene blue plates, second gas test, and morphological examination. The latter step was discontinued after a considerable number of the colonies proved to be non-spore-forming, Gram-negative rods without exception. Of the 404 colonies, 377 or 93.3 per cent were confirmed as members of the colon-aerogenes group. An analysis of the 27 colonies (6.7 per cent) failing to meet the technical requirements of the standard methods for the colon-aerogenes group is given in table 1.

Comparative results by the cyanide citrate plate method and the standard lactose fermentation method

Comparative tests were made of 1051 samples of water from Lake Michigan, private wells, and swimming pools and of sewage, simultaneously by the Standard Method (12) and the cyanide citrate pour plate method, with interesting results.

In this series, the direct plate method of demonstrating the Colon-aerogenes group gave 68.3 per cent of positive samples and the fermentation tube method 64.2 per cent. Of 376 samples found negative by the fermentation method, 141 or 13.4 per cent of the whole number were positive by the plate method. Conversely, of 333 samples showing no Bacterium coli by the plate method, 98 or 9.3 per cent of the whole number were positive by the fermentation method. Quantitatively, the Bacterium coli index by the plate method equalled or exceeded that of the tube method in 76.7 per cent of the samples and was less than by the tube method in 23.3 per cent of the samples.

Plate indices consistently exceeded tube indices in the lower dilutions, but in general were lower in the upper dilutions. In the lower dilutions both types of the indices are from equivalent volumes of inoculum. In the upper dilutions, the tube indices, in general, represent inoculations which were fractional of the amounts used in the plate method. The difference, we believe, is explained by the effect of dilution.

DISCUSSION

It is well to emphasize the need of shortening the three- to four-day period now required to furnish a colon-aerogenes group index by the lactose broth tube method. The cyanide citrate plate method affords these data in forty-two to forty-eight hours. Not only is the

plate coli index method shorter, but it is also more accurate than the tube method, since it does not possess the inherent errors of the multiple fraction dilution method. Moreover, numerous workers, and more recently Greer (1928) (13) have shown that the lactose broth tube is often productive of pseudo-presumptive reactions and antibiosis or both. A pseudo-presumptive test may be due to synergism (14) or to spore formers in the medium. Antibiosis may account for the failure to recover a colon organism initially present. Both the fecal and the grain types of Bacterium coli may be initially present, but only the fecal or only the grain type may survive the incubation period. Or again, both types may survive. The end product of the presumptive test, in other words, may not represent the true initial content of the sample either qualitatively or quantitatively. The cyanide citrate medium, on the other hand, avoids the phenomena of synergism and antibiosis, and permits development of each free organism into a colony, unhampered by its neighbor.

The Bacterium coli content of a polluted water may, if desired, be expressed in terms of fecal and non-fecal types as measured by the Standard Method methyl red and Voges-Proskauer reactions. The new medium gives great promise of affording a direct means of distinguishing the fecal from the aerogenes type of Bacterium coli. Many strains of each type present a distinctive appearance on the medium. Certain intermediate strains, however, appear at present to be insufficiently distinguishable. Further work is to be done on this property of the medium.

The reduction in time required to furnish an index and the inherent improvement in qualitative and quantitative dependability favor the cyanide citrate medium.

The trend of thought among those sanitarians whose work is concerned with the colon-aerogenes index of water and sewage, is that there is need for an improved method of index determination. This opinion is best expressed from a mathematical viewpoint by Streeter (1927) (15) and from a technical viewpoint by H. E. Jordan (1927) (16). In his discussion of Bacterium coli results obtained from primary series of experimental studies of water purification, Streeter says, "The numerical results given by the index tube method, as applied to individual tests, fail to give even a close approximation of the true results as indicated by the theory of probability, as was originally brought out by McCrady." In his report of the collaboration studies of brilliant green bile for the detection of the colon

aerogenes group, Jordan summarizes the objections to the present method of index determination in the statement:

But at the present time, while a number of workers recognize the limitations of the present standard practice, there is a certain tendency on the part of others to overlook defects. Putting the objections briefly, they are as follows:

1. The complexity of growth in lactose broth is often so great as to make the isolation of colon group organisms difficult.
2. Synergism is responsible for a very large number of cases in which gas is produced, but no plate growth follows. In water supplies where this occurs, the "presumptive" test is recognized as having little significance.
3. The diagnostic value of Endo or E.M.B. plates varies materially in waters of different degrees of pollution. It appears that in waters not freshly polluted where synergistic growths are frequent the picture that the plate affords is less useful than in freshly polluted waters.
4. Many laboratories appear to carry on to completion subcultures from a plate on which the growth is massive and mixed rather than from a more sparsely planted plate on which the colonies are well separated and distinct..

In the opinion of the writer, the cyanide citrate medium just described is yet in the experimental stage. It is believed capable of considerable improvement and refinement. Potentially it may be very valuable to the filter plant operator and sanitarian, to the water bacteriologist and quite probably to the dairy bacteriologist.

In subsequent reports it is planned to present data and conclusions relating to certain phases of the use of cyanide citrate agar versus liquid media for colon-aerogenes index determination.

ACKNOWLEDGMENT

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DISCUSSION

A. E. Gorman:[4] Mr. Noble's excellent paper, while based on results obtained in examining Lake Michigan water supplying the city of Chicago, is certain to be of wide importance and interest to the entire water works profession. Experience with routine water safety control in Chicago indicates that antibiosis by B. coli and Cl. welchii must be reckoned with seasonally in interpreting the results of presumptive tests for the former group of organisms. This is a serious factor and undoubtedly must be contended with in many other cities. The cyanide citrate method of direct plating offers a solution for this difficulty which has long been needed. Based on past results the decline in B. coli in Chicago's water occurs in the winter and spring months, when Cl. welchii is quite prevalent. We are confronted with the problem of finding out if this is real or apparent and are hopeful that Mr. Noble's work will solve it.

[4] Chief Sanitary Engineer, Division of Water Safety Control, Chicago, Ill.

CONCRETE CONTROL METHODS IN THE CONSTRUCTION OF A FILTERED WATER RESERVOIR[1]

By W. C. Mabee[2]

The purpose of this paper is to bring before the Association the application of the newer and more scientific methods of field control of concrete to the construction of an important water works structure. The writer hopes it will prove of interest to the society and a benefit to those engaged in concrete work, particularly in water works structures.

This reservoir was constructed in 1926 at the Fall Creek Station of the Indianapolis Water Company by the local organization of the Thompson-Binger Co. of New York, General Contractors. It occupies a space approximately 270 feet square and has a gross area of over 60,000 square feet, with an overall depth of 16 feet, and a storage capacity of 6 million gallons. The roof is a flat slab, 8 inches thick supported by circular columns, 20 inches in diameter, spaced 16 feet centers and resting upon a groined-arch floor having a minimum thickness of 8 inches.

Local ground water conditions made necessary the provision that the structure and its loading should have weight sufficient to balance an upward pressure of ground water at flood times with the reservoir nearly empty,—hence the groined arch floor design. Incidentally, the arched floor forms valleys which permit easy cleaning.

QUANTITY AND QUALITY OF CONCRETE

The reservoir contains over 5000 cubic yards of concrete of two grades. The floor and wall concrete was made with a water-cement ratio by volume of 0.8 or 6 gallons of water per cubic foot of cement and the flat slab 0.83 or $6\frac{1}{4}$ gallons as near as it could be determined within practical limits, aiming at a 28 day strength not less than 2500 pounds per square inch in compression, and a water-tight concrete throughout.

[1] Presented before the Indiana Section meeting, February 17, 1927.
[2] Acting Chief Engineer, Indianapolis Water Company, Indianapolis, Ind.

RESULT OF TESTS

Two 6-inch diameter cylinders, each 12 inches long, were made each day from the same batch, taken after it was deposited in the forms. They tested as follows:

6-GALLON MIX $\frac{W}{C} = 0.8$				$6\frac{1}{4}$-GALLON MIX $\frac{W}{C} = 0.83$			
Number of tests	7 days average	Number of tests	28 days average	Number of tests	7 days average	Number of tests	28 days average
	lbs. sq. in.		*lbs. sq. in.*		*lbs. sq. in.*		*lbs. sq. in.*
31	2,180	24	3,520	10	1,830	10	3,200
Maximum..	3,240		4,690		2,510		4,350
Minimum..	1,480		2,430		910		2,250

Grouping these results and comparing them with Abrams Curve the 6 gallon mix yielded an average strength at 28 days of 3,570 pounds per square inch for 45 samples broken, after making allowance for increase in 28-day strength over 7-day strength, corresponding to 3000 on Abram's Curve "A." The $6\frac{1}{4}$-gallon mix indicated a somewhat similar result. These results were gratifying and were made possible by:

1. Care in the selection of aggregates and in the combination of sand and gravel.
2. Selection of the Water-Cement Ratio and the design of the mix that would make a workable concrete.
3. Reasonably careful measurements of aggregates as delivered to the mixer.
4. Actual measurement of the water added to each batch after making an allowance for moisture in sand and gravel.
5. Control of the time of mixing by the use of a time lock on the mixer.
6. Distribution of the concrete to its position in the work without segregation of materials.
7. Agitation or puddling in forms, particularly in narrow walls or columns, and
8. Curing the concrete under wet or moist conditions.

These are the important steps in the field control of concrete which, if given reasonable care and attention, promote better uniformity in concrete construction.

IMPORTANCE OF CONCRETE

The importance of concrete construction in the United States can be the better appreciated when it is known that of the 7,500 million dollars involved in construction operations last year over 1000 million dollars went into concrete and over 170 million barrels of cement were manufactured and marketed in this country.

The industry is so important that it merits all the study that can be given it. Last year over 12,000 students attended schools conducted by the Portland Cement Association, and in Louisville last week 200 engineers and contractors attended the short course in "Design and Control of Concrete Mixtures."

Much valuable information can be acquired by a study of their methods. They teach the theory now ten years old, that the strength of concrete is controlled largely by the amount of water mixed with the cement, which is termed the water-cement ratio. It is a generally accepted fact today that such is the case, but there is still considerable discussion as to proper methods of proportioning the aggregates.

DEPARTURE FROM USUAL PRACTICE

The letting of a contract in Indianapolis for concrete proportioned by the water-cement ratio was so far as the writer has knowledge the second instance of this kind. In order therefore to eliminate the uncertainty of the contractor as to the amount of cement that would be required, and to enable all bids to be made on a comparable basis, the Company fixed the quantity at $1\frac{1}{2}$ barrels per cubic yard of concrete, with a provision in the contract for compensation if more than this amount were used and a saving to the company if less cement was used.

The quantity actually used amounted to 1.535 barrels per cubic yard or $2\frac{1}{3}$ per cent in excess of the amount estimated. This included cement used in top finish dusting, where a trowelled surface was specified. This provision in the contract removed the incentive to skimp the work on the part of the Contractor and was a satisfactory arrangement for the owner.

STRENGTH

The specification provided that the strength of test specimens at 28 days should be 2500 pounds per square inch. Twenty-four

cylinders tested at 28 days taken from concrete mixed with a water-cement ratio of 0.80 developed the following strength:

Less than 2500 pounds per square inch	1 cylinder
2500 to 3000 pounds per square inch	7 cylinders
3000 to 3500 pounds per square inch	5 cylinders
3500 to 4000 pounds per square inch	5 cylinders
4000 to 4500 pounds per square inch	5 cylinders
Over 4500 pounds per square inch	1 cylinder

Average 3520 for the 24 cylinders

COMBINING AGGREGATES

The first step in the design of the field mix after assuming the water-cement ratio of 0.80 or 6 gallons of water to the sack of cement was to determine the ratio of fine to coarse aggregates. This was done in the manner prescribed by the Portland Cement Association Manual and involved screening, drying and weighing.

The sand and gravel obtained locally was washed and screened and proved satisfactory in every way. It was combined with a fineness modulus of 5.6.

While the field mix was calculated approximately 1:1.9:3.5 it is probable that the actual mix was nearer 1:1.7:3.4 as reflected in the quantities of aggregate actually purchased. The sand and gravel were stored in separate bins and discharged into a measuring hopper divided into two sections, which were marked off by trial to hold their respective quantities.

MOISTURE IN AGGREGATE

Numerous tests for moisture in the sand yielded results ranging from 3.7 per cent by weight measured loose to $12\frac{1}{2}$ per cent with an average of 7 per cent. The coarse aggregate indicated about 3 per cent.

WATER CONTROL

Six gallons of water to the sack of cement was the maximum water allowed. Because of the wide variation of moisture in the sand the quantity of water added to each batch was usually determined from the higher percentages found, so that in all probability the water-cement ratio was somewhat less than 0.80. A tank calibrated to a scale graduated to gallons was used to measure the additional make-up water and care was exercised in filling this tank to the required level.

If it were found necessary to increase the workability of the concrete, this was done by reducing the quantity of aggregates, usually the coarse aggregate, and allowing the water-cement ratio to remain constant. Four sacks of cement were used in a batch and from 16 to 18 gallons of water added. Each batch contained two-thirds of a cubic yard of concrete.

TIME OF MIXING

Increasing the time of mixing produces a somewhat stronger, more workable, more homogeneous and consequently a more nearly watertight concrete.

The time of mixing was $1\frac{1}{2}$ minutes, which is a half minute longer than the usual allowance and was accomplished by means of a timelock on the mixer. The discharging lever could not be operated until a gong sounded announcing that the time interval had elapsed. The $1\frac{1}{2}$ minutes are measured after all materials are in the mixer and until the batch is discharged.

This scheme worked to the advantage of the contractor and owner alike.

TRANSPORTATION OF CONCRETE

A short tower and hoist were used to raise the concrete from the mixer in a pit to an elevation that would permit it to fall into a hopper from which point it was discharged into concrete carts and wheeled to position without segregation.

SLUMP TESTS

At least two slump tests were made daily and varied from 1 to 8 inches, usually about 3 inches in the floor concrete and about 6 inches in the flat slab and 7 inches in the walls. They were made in the regular way. The slump test is a useful index to workability and indicates whether the concrete is too stiff or too wet. Visual observation of uniformity is not sufficiently reliable, however experienced the observer may be.

PLACING IN FORMS

Reservoir concrete is intended to prevent the percolation of water and it was essential that the mass be puddled quite thoroughly to prevent honeycombing and to present a smooth surface upon the

removal of forms. The floor was dusted with a mixture of sand and cement and trowelled smooth while the concrete was still plastic. Absolutely tight forms are not essential as excess water that escapes through forms reduces water-cement ratio and increases strength.

CURING

It has been found by experiment that concrete moist-cured will develop from $1\frac{1}{2}$ to 3 times the 28-day strength of dry-cured concrete. Concrete is kept wet not to permit moisture to enter, but to prevent the moisture that is already there from escaping until the chemical reactions have been completed. The floor was covered with burlap and kept wet for 7 days. The roof was flooded by means of mortar dams built about the margins of each day's work and an effort made to keep it flooded for a week. No practical way was found for keeping the walls moist except that the forms were allowed to remain for a longer period than would otherwise have been necessary.

CONTRACTOR'S PLANT LAYOUT

Local conditions were in favor of a simple plant layout. Cement was brought in on the station coal trestle, chuted down into the cement house and wheeled a very short distance to the mixer.

By placing the mixer in a pit just outside the structure it was possible to chute sand and gravel from the unloading bins directly into the measuring hopper over the mixer. The short tower and hoisting engine did the rest. Concrete carts were used for transporting concrete.

PROGRESS OF WORK

Ten weeks were required to complete the work, the average rate of placing being 500 cubic yards per week elapsed time. After the first two weeks the contractor struck his stride and the rate of progress from then on was fairly uniform.

INSPECTION OF WORK

A resident engineer was placed in charge of this work and he was given an assistant engineer. Both acted as inspectors, gave lines and grades, made test cylinders, slump tests, sieve analyses, moisture determinations and reported daily progress and quantities involved.

TESTING WATERTIGHTNESS

A leakage test extending over a period of 24 hours made several weeks after the completion of the work indicated a loss of 21,000 gallons or about $\frac{3}{10}$ of 1 per cent excluding evaporation. The depth of water at test was 14 feet.

DURABLE CONCRETE

In structures designed to withstand exposure to water and weather, the strength factor is secondary to density. Concrete that will flow in chutes is too wet for this character of work unless the aggregate is reduced while maintaining the same water-cement ratio. Good materials otherwise suitable may be spoiled by too much water. Durability can only be obtained by subordinating strength and economy. A concrete amply strong for the required loadings may be of such a porous nature that it will not withstand the elements and will in a few years show signs of disintegration.

Porosity occurs when very wet mixtures are used causing segregation of the materials in handling. Disintegration sets in when moisture enters and is assisted by freezing with its consequent expansion and disruption. This usually begins at the water line, but may occur at day joints improperly made, permitting water to percolate through the structure, giving opportunity for saturation and subsequent freezing.

The requirements for durable concrete are clean aggregates, a fairly rich mixture, placing without segregation and proper curing.

SHORT CUTS IN WATER CONTROL

In the general run of building operations in Indianapolis the sand is brought to the site of the work where there is small storage space. Consequently there is slight opportunity for the moisture to escape and, in the absence of scientific water control, a good practice is to deduct one gallon of water from the quantity required under the assumed water-cement ratio for each cubic foot of sand that goes into the batch.

This allowance compensates for about 9 per cent of moisture in the aggregates.

I heard of an instance where a conscientious contractor had installed an overflow pipe from the water tank which led out over the

head of the operator and when the tank overflowed the water fell on the man. Of course, it did not overflow very often.

Acknowledgment is made for the co-operation and assistance of Carl Geupel, the local representative of the Thompson-Binger Co. and to B. J. T. Jeup, Chief Engineer of the Indianapolis Water Company, and to the local representatives of the Portland Cement Association.

COLORIMETRIC pH DETERMINATIONS IN A NEUTRAL ATMOSPHERE

By Henry F. Muer[1] and Frank E. Hale[1]

In the course of routine determinations of the pH of various waters by the colorimetric method certain erratic results were obtained for which no cause was apparent at the time. This was especially noticed when experimenting with distilled water. The results upon the laboratory tap water varied on different days and sometimes at different times on the same day. The values for distilled water given by various observers range from pH 5.4 to pH 6.8. In our experiments the values were seldom twice alike no matter how carefully it was prepared, ranging usually from pH 5.4 to about pH 6.0. The differences observed in natural waters were smaller. Those with the higher alkalinities gave fairly uniform results.

Since the theoretical value of distilled water is pH 7.0, and since some workers have obtained values as high as pH 6.8, it was finally decided that the cause of the erratic results as well as the persistent high acidity of the distilled water must be due to the condition of the laboratory atmosphere, and not to changes in the water. At this point it may be proper to describe the method of making this test as practiced at this laboratory.

The test is made in glass-stoppered salt-mouth bottles of a capacity of 50 cc., using 20 cc. of the water and 1 cc. of the indicator prepared according to Clark & Lubs. The standards are prepared in sterilized bottles of the same kind, made from a "Universal" buffer solution prepared by the Pyro-electric Instrument Co., and when not in use kept in a dark place. It was found repeatedly that these standards did not deteriorate even after two and one-half years of constant use, as shown by comparison of new sets with old ones.

In order to ascertain how much the atmospheric conditions in the laboratory affected the results, a liter of distilled water from the stock reservoir was treated with air which had been neutralized by passing through two gas-washing bottles containing 60 per cent KOH solu-

[1] Chemists, Mount Prospect Laboratory, Department of Water Supply, Gas and Electricity, New York City, N. Y.

tion, another of lime water, then an empty one to serve as a spray trap. At the same time two of the 50 cc. salt-mouth bottles regularly used for the tests were fitted with two-hole rubber stoppers with a long and a short glass tube, the long tube extending to about $\frac{1}{4}$ inch from the bottom of the bottle and the short one ending at the under side of the rubber stopper. Both tubes were fitted with rubber tubing for connections and pinchcocks. Before making the regular experiments as planned, a preliminary run was made in which one of the test-bottles equipped as described and containing 20 cc. of the same distilled water as that in the large aspirator, plus 1 cc. of bromthymol-blue indicator, was connected in the line between the neutralizing train and the distilled water container, and another one between the distilled water container and the suction. When the suction was started the air passed first through the neutralizing train, then through one of the test-bottles, then through the distilled water in the large aspirator, then through the second test-bottle, then out. Before the run the distilled water in the two test-bottles with the indicator was acid beyond the bromthymol-blue range. It was bright yellow, probably about pH 5.6, as judged from previous tests. Soon after the suction was started the first test-bottle began to change color. Gradually it turned more and more green until after about 45 minutes it had reached a color matching our pH 7.0 standard. It remained stationary at this point despite one-half hour of further treatment. The second test-bottle which received the air after bubbling through the liter of distilled water in the large aspirator required a much longer time to change color, but it also reached a color matching pH 7.0, and remained stationary at this point for about one-half hour, when it was necessary to stop operations on account of other work.

The second run was made later under different conditions. The two small test-bottles were connected as before, but contained only 1 cc. of bromthymol-blue indicator and no water. Both were connected in series between the neutralizing train and the distilled water container. The purpose was to fill them with neutralized air for subsequent tests. The run was continued with the neutralized air bubbling through the distilled water as before. When the run was stopped each of the test-bottles filled with neutralized air and containing 1 cc. of bromthymol-blue solution was connected to the aspirator containing the washed distilled water with suitable precautions to exclude the laboratory air, and 20 cc. of the washed distilled water was slowly run into each of the test-bottles. Both read exactly

pH 7.0 on our standard. A sample of the same washed distilled water was then tested according to our routine method and read pH 6.1.

From these tests we conclude that our pH 7.0 standard is correct, and that the difficulty experienced with our distilled water was due to the acidity of the laboratory air. Another run made subsequently gave practically the same results. Several runs were then made with

TABLE 1

pH determinations on distilled water

Alkalinity = 0

	pH VALUES		
	Routine method	Modified method	Neutral atmosphere method
1. Purified by washing with neutralized air...	6.1		7.0
2. From 5-gallon stock bottle................	5.5		6.1
3. Washed with neutralized air...............	6.6		7.3
4. This test was made in a bottle in which the indicator had been kept twenty-four hours due to interruption of work; on transferring to an ordinary bottle with unpurified air and reading as quickly as possible....	6.6		
5. Purified by washing with neutralized air...	6.1		6.95
6. From 5 gallon stock bottle about half full...	5.6	5.7	5.9
7. Kept in small aspirator bottle about 5 weeks tightly stoppered......................	5.6	6.2	7.4
8. Boiled in Pyrex flask and cooled, protected by fresh soda lime tube. 4/22/27........	5.8	6.5	6.9
9. Another sample from the same flask as above. 5/17/27........................	6.1		
10. Another sample from the same flask as above. 6/25/27........................	6.0	6.1	6.2

Catskill and Croton waters, the results of which are shown in tables 1, 2 and 3.

Another series of experiments was then made, in which the samples were collected and handled in a manner similar to that used for samples to be tested for dissolved oxygen. These samples were specially collected and brought to the laboratory immediately. The portions for test were withdrawn through a siphon tube coupled with a soda lime tube in a 2-hole rubber stopper, run into a 40 cc. glass stoppered

bottle with the siphon tube inserted to the bottom, and allowing the bottle to fill by upward displacement and overflow about double its

TABLE 2

pH determinations on Catskill water

Alkalinity = 7–9 p.p.m.

	pH VALUES		
	Routine method	Modified method	Neutral atmosphere method
1. Laboratory tap	6.65		6.95
2. Laboratory tap, 9:30 a.m.	6.7	7.2	
3. Laboratory tap, by filling beaker and taking test-portion from this		6.95	
4. Laboratory tap, late afternoon	6.7	6.9	
5. Laboratory tap, 9:30 a.m. 2/26/27	6.9	7.3	
6. Laboratory tap, 9:30 a.m. 2/28/27	7.0	7.2	
7. Laboratory tap, 3:20 p.m. 2/28/27	6.6	6.8	
8. Laboratory tap, noon. 3/1/27	6.6	6.8	6.95
9. Laboratory tap, 2:00 p.m. 3/4/27	6.7	7.0	7.05
10. Laboratory tap, 1:45 p.m. 3/23/27	6.8	7.0	7.4
11. Shaft no. 23, specially collected	6.5	6.65	6.95
12. Laboratory tap, 4:00 p.m. 6/24/27	7.1	7.2	
13. Laboratory tap, 4:00 p.m. 6/24/27	7.1	7.1	
14. Laboratory tap, 4:40 p.m. 6/24/27		7.1	

TABLE 3

pH determinations on Croton water

Alkalinity = 30–32 p.p.m.

	pH VALUES		
	Routine method	Modified method	Neutral atmosphere method
1. New Aqueduct, chlorinated, 1-quart bottle filled to overflowing	7.1	7.2	
2. Old Aqueduct, chlorinated, 1-quart bottle filled to overflowing	7.2	7.3	
3. Tap, 9th Avenue, specially collected	7.1	7.05	7.2

volume. Two cc. of bromthymol-blue indicator were then slowly run in through a pipette with the point dipping just below the surface of

the water. The stopper was then inserted, the contents mixed by shaking and readings taken. The results of these tests were somewhat better than those obtained by our routine method, but in general they were still inferior to those obtained in the test-bottles filled with neutralized air. In the tables the first column shows the results obtained in our routine method; the second column shows the results obtained on samples of the same waters collected as for dissolved oxygen; the third column shows the results obtained in the test-bottles filled with neutralized air.

Although these experiments are of a preliminary character and made more or less at random, it was thought that the results might be of interest and might perhaps help to demonstrate the desirability of definitely standardizing a method for water work. From the results obtained and from observations made during these tests the following conclusions may be drawn:

The colorimetric pH test when made in a neutral atmosphere is applicable where the direct electrometric test cannot be made accurately.

In order that all tests made by various workers in different localities under different conditions may be comparable, some method taking into account the conditions herein indicated should be standardized, especially for waters of low alkalinity. When it is considered that a change from pH 7.0 to pH 6.0 is only of the order of one-millionth of normal hydrogen ion concentration, the effect of the laboratory atmosphere may at times be considerable. In a situation such as ours where the air is constantly filled with CO_2 from the many gas burners used, and with HCl fumes from numerous iron determinations, the effect may be much greater than in a laboratory where these conditions do not obtain. This is illustrated to some extent by the results of tests upon our laboratory tap water. Those made early in the morning before the day's work was well started, especially on a Monday morning, are less acid than others made later in the day. The fall of pH 0.4 in the pH of the laboratory tap shown on February 28 is not at all likely to be due to changes in the water.

The results of the tests are also influenced, especially in waters of low alkalinity, by the manner in which the sample is collected and kept. Generally the tests should be made on the spot. Tap samples are more easily handled than any others; reservoir samples should be collected by the two-bottle overflow method used for dissolved oxygen samples and tested immediately.

The kind of glass of which the various vessels are made also affects the results to some extent. This may be seen in the results upon distilled water kept in a flint glass aspirator which became alkaline, and in the same water kept in a pyrex flask which became acid despite the fact that it was carefully protected with a soda lime tube.

Valuable assistance in the manipulations and tests was given by S. Askowitz, bacteriologist and member of the laboratory staff.

SUMMARY

Comparison is made of the results of colorimetric pH determination obtained by three methods:

1. 20 cc. of water in a 50 cc. glass stoppered bottle plus 1 cc. of indicator; routine method.

2. 40 cc. of water in a 40 cc. glass stoppered bottle filled by overflowing, thus displacing the contained air, then adding 2 cc. of indicator by displacement of some of the water; modified method.

3. Same as No. 1, but the test-bottles were previously filled with neutralized air, and the samples added with complete exclusion of the laboratory air; neutral atmosphere method.

ENDEMIC GOITER AND DRINKING WATER IN OREGON[1]

Comprehensive determinations of iodine in Oregon water supplies are lacking. However, the few available analyses indicate a paucity of iodine in the water. McClendon reports 0.03 and 0.10 part of iodine per billion parts of Bull Run water, with which Portland is supplied.[2] In a sample of water from the Clackamas River, glacial in origin, 0.06 part of iodine per billion was found. It is interesting to note in this connection that the greatest amount of endemic goiter among girls was found in Oregon City, which uses the untreated water from the Clackamas River.

A sample of water from Marshfield, Oregon, examined by J. F. McClendon, of the University of Minnesota, since the thyroid survey was completed, failed to disclose the presence of iodine. The paucity of iodine in the drinking water of Oregon can be better appreciated when a comparison is made with the iodine content of waters in other sections of the country. Thus, the water of New York City has 2.50 parts of iodine per billion, while that of Stanford, Calif., has 105.80 parts per billion.

Although the inverse relation between goiter incidence and iodine content of water, as suggested by McClendon, appears to hold true in general, there are numerous exceptions to the general rule. One of these, the absence of iodine from the water used for drinking purposes in Provincetown, Mass., where goiter is almost nonexistent, has been indicated in a previous publication.[3] In this instance, of course, requisite iodine is undoubtedly ingested in sea food.

In Oregon a deficiency in iodine in both water and food is probably responsible in a large degree for the considerable incidence of simple

[1] Abstract from "Endemic Goiter in Oregon," by Robert Olesen, U. S. Public Health Reports, vol. 42, no. 46, November 18, 1927.

[2] McClendon, J. F., and Hathaway, J. C., Inverse relation between iodine in food and drink and goiter, simple and exophthalmic. Jour. A. M. A., vol. 82, no. 21, p. 1668, May 24, 1924.

[3] Olesen, Robert, and Taylor, N. E., Endemic thyroid enlargement in Massachusetts, Public Health Reports, vol. 42, no. 12, pp. 804–816, March 25, 1927.

goiter. Determinations of iodine in Oregon fruits and vegetables by McClendon have disclosed unusually small quantities of iodine.

GOITER AND POLLUTED WATER

Inasmuch as McCarrison has recently reiterated his conviction that endemic goiter is due to the consumption of polluted water, the direct causative agent being an unidentified living organism, it is of interest to institute an inquiry concerning the safety of water supplies in Oregon.[4] Marine and Kimball, discussing this point, contend that "if water is a factor, it would seem that it is the absence rather than the presence of some substance which is to be considered, since goiter is associated with the purest of waters, chemically and bacteriologically, as, for example, in Portland, Oregon, and in Seattle and Tacoma, Wash., where there has been a rapid increase in goiter since these cities began to take their water supplies from the Cascade Mountains.[5]

From information supplied by the state board of health of Oregon, it is evident that practically all of the water supplies of cities and towns where thyroid examinations were made are safe for human consumption. In fact, many of the supplies coming from uninhabited mountain water sheds, would appear to be safe without treatment. However, in order to provide an additional factor of safety, some of the supplies are filtered and chlorinated. It does not appear that any of the waters listed are polluted or unsafe. Neither is there evidence, with the exception of the Oregon City supply, that endemic goiter is more frequent in places in which no water treatment is instituted. Under the circumstances McCarrison's belief that this form of goiter is due to the consumption of polluted water cannot be substantiated in Oregon.

[4] McCarrison, Robert, An experiment in goiter prevention. British Med. Jour., January 15, 1927, p. 94. Abstract in Public Health Reports, vol. 42, no. 12, March 25, 1927.

[5] Marine, David, and Kimball, O. P., The prevention of simple goiter in man. Jour. A. M. A., vol. 77, no. 14, pp. 1068–1070, October 1, 1921.

SOCIETY AFFAIRS

IOWA SECTION

The thirteenth annual meeting of the Iowa Section was called to order by Chairman J. W. McEvoy, in the Banquet Room of the Hotel Chieftain, Council Bluffs, Iowa, Wednesday, September 28, 1927. There were forty-six persons present. Honorable S. A. Green, Mayor of Council Bluffs, officially welcomed the Section to Council Bluffs on behalf of the city. J. Chris Jensen, Trustee of the Council Bluffs City Water Works, extended the welcome of the Council Bluffs Water Works authorities and explained the plans of the local committee for the entertainment of the Section. Chairman J. W. McEvoy replied to the addresses of Mayor Green and Trustee Jensen. He also called attention to the proposed discussion for Thursday on the subject of the Manual of the American Water Works Association.

Topic No. 3, The Maintenance of Distribution Systems, was opened by H. F. Blomquist. The topic was discussed by J. W. McEvoy, Harry Corcoran, Homer V. Knouse, F. L. Burrell, A. E. Skinner, R. Rees, Arthur E. Johnson, C. J. DeLacy, and George W. Cox.

Topic No. 5, Meters for Automatic Fire Sprinkling Lines, was discussed by N. T. Veatch, Jr., C. L. Ehrhart, Harry Corcoran, J. W. McEvoy, H. F. Blomquist and R. Rees.

Topic No. 6, Number of Employees for Water Works per Million Gallons Pumped, was discussed by H. F. Blomquist, R. Rees, J. J. Myrtue, J. J. Hail and J. W. McEvoy and Homer V. Knouse. The number of employees per million gallons per day ranged from six to ten.

The afternoon session was called to order by Chairman McEvoy at 2:50 p.m. On account of the absence of Mr. Jenks, his paper was passed over for the time, and Mr. Pedersen's paper, entitled "The History of the Marshalltown, Iowa, Water Works" was read. The paper was discussed by Homer V. Knouse and J. W. McEvoy.

The next paper to be read was entitled "The Relation of Turbidity to Coagulant Dosage" by Kenneth C. Armstrong. Mr. Armstrong's

paper was discussed by H. F. Blomquist, Jack J. Hinman, Jr., N. T. Veatch, Jr. and the author.

Following Mr. Armstrong's paper Homer V. Knouse showed a series of moving pictures illustrating the construction activities of the Metropolitan Utilities District. The pictures were taken and prepared by the Division of Publicity of the Utilities District. The material presented was discussed by J. W. McEvoy and Thomas B. Maloney.

Mr. Hinman, the Secretary, then read the paper entitled "Filter Plant Operation at Variable Rates" by Harry N. Jenks.

Topic No. 9, Billing Machines, was then taken up and discussed by C. J. DeLacy, H. F. Blomquist, W. M. Householder, H. V. Pedersen and J. J. Hail.

Following this discussion those present at the meeting were taken by automobile to the Florence Filter Plant and Pumping Station of the Metropolitan Utilities District, of Omaha. After an inspection of the pumping station, basins, and filter plant of the Florence Station an excellent complimentary dinner was served by the Metropolitan Utilities District on the operating floor of the filter plant. The dinner was prepared by the ladies of the Florence Presbyterian Church. After the dinner the members of the Section were taken by automobile to the Walnut Hill Reservoirs and to the Service Building of the Metropolitan Utilities District.

The morning session of Thursday, September 29, opened with a discussion of the topics treated in the Manual of the American Water Works Association. The general opinion was that the greatest need of the Manual was a very carefully prepared index, with many cross references. Some of the members reported difficulty in finding material when they wished to refer to it. It was found that few of those present had read the book from cover to cover, but that most of those who had had the opportunity to use it were pleased with the discussion of general principles which the book contained.

Homer V. Knouse, in discussing the desirability of an index, called attention to the fact that an index of all of the publications of the American Water Works Association would be an exceedingly useful book. He called attention to the number of times his organization had attempted to get together all the information on certain subjects contained in the proceedings of the society and in the Journal which has been issued in later years. He also wished a more extended discussion of the subject of uniform statistics of water works in the Manual.

H. V. Pedersen thought that the Manual was somewhat too difficult in tone for a small water works operator. He said that he believed, in general, short, simpler summaries with concrete examples were more useful to the plant operator.

H. F. Blomquist expressed his desire for information concerning methods and frequency of billing and various charges in connection with operation and services. He felt that information concerning the statistics of water works plants, rates, and the like in even more extended form than that recently collected by the American City Magazine should be supplied through some such medium as the Manual.

R. L. Baldwin seconded Mr. Knouse's remarks with regard to the desirability of an index and thorough cross references.

John W. Pray expressed his desire for more statistics.

Harry Corcoran called the attention of the Section to the fact that the Manual was not intended as a handbook, and expressed his belief that it would be a desirable thing to include statistical material for detailed information in an appendix.

In closing the discussion, Homer V. Knouse, of Omaha, discussed, the difficulty of getting information of the sort desired by means of questionnaires and suggested that the coöperation of manufacturers and their agents be solicited.

The Section then proceeded to the reading of papers, as follows:

Present Tendencies in the Examination of Waters, Jack J. Hinman, Jr. This paper was discussed by John W. Pray, H. F. Blomquist, C. O. Bates, W. M. Householder, H. V. Pedersen, C. L. Ehrhart and J. W. McEvoy. During the discussion the undesirability of collecting specimens from fire hydrants was mentioned. It was pointed out that yard hydrants also suffered from the same possibility of contamination of specimens through the drip cock of the hydrant.

The Use of Chloramines in the Sterilization of Water, Kenneth C. Beeson. Mr. Beeson's paper was discussed by K. C. Armstrong, H. V. Pedersen and H. F. Blomquist.

The afternoon session of Thursday, September 29 was called to order by Chairman McEvoy. In the absence of the author, Secretary Hinman read the paper entitled "Runoff from Small Catchment Areas in Southern Iowa," by Floyd A. Nagler. This paper was discussed by N. T. Veatch, A. H. Wieters, H. V. Pedersen and H. F. Blomquist.

The paper entitled "Municipal and Public Utility Accounting and Financing," by J. Joseph Hail was then read. This paper was discussed by H. F. Blomquist and John W. Pray.

On account of the sickness of George W. Burke the two papers scheduled to be read third and fourth on the afternoon program were omitted. These papers were "Notes on the Oxygen Consumed Determination in Connection With Wastes of High Concentration," by George W. Burke and "The Determination of Nitrates and Nitrites in Trade Wastes," by Max Levine and George W. Burke.

In place of the foregoing two papers, G. W. Boswick, of the Westinghouse Electric Company, of Pittsburgh, Pa., gave an illustrated paper entitled "The Application of Electric Motors and Control to Water Works." This paper was discussed by R. L. Baldwin and Homer V. Knouse.

Chairman McEvoy announced the following committees to serve at the meeting: Nominating Committee: H. F. Blomquist, Chairman, N. T. Veatch, Jr., J. J. Myrtue. Resolutions Committee: R. L. Baldwin, Chairman, C. D. Hayes, John W. Pray. Auditing Committee: R. Rees, Chairman, Harry Corcoran.

The Section adjourned until seven o'clock, when it met in the Banquet Hall of the Hotel Chieftain for a banquet and entertainment given by the courtesy of the manufacturers agents. An excellent dinner was served to about one hundred and fifty diners. Musical entertainments and talks were features of the program.

The session of Friday morning, September 30, was called to order by Mr. McEvoy, who read a letter from Thomas J. Skinker, Vice Chairman, expressing his regret at his inability to be present at the meeting on account of an injury connected with his war service. The following papers were read:

The Effect of Lactose Bile and Brilliant Green Bile Media Upon Non-Confirming Gas Formers in the Omaha Water Supply, by Kenneth C. Armstrong. This paper was discussed by K. C. Beeson and Jack J. Hinman, Jr.

The Use of Electrolytic Cells in Chlorination for the Destruction of Algae, Joseph B. Thornell. This paper was discussed by H. V. Pedersen.

The New Council Bluffs Water Works Pumping Station, Arthur L. Mullergren. Mr. Mullergren's paper was discussed by Homer V. Knouse, J. W. McEvoy and H. F. Blomquist.

The Section then went into business session.

Mr. Rees reported for the Auditing Committee that the books of

the Secretary-Treasurer had been audited and found correct. The report was accepted.

R. L. Baldwin presented the following resolutions to the Section:

I. *Be It Resolved* by the Iowa Section of the American Water Works Association that the convention held in Council Bluffs, Iowa, September 28, 29 and 30, has been a highly satisfactory and beneficial meeting to those attending, and that the Secretary be hereby instructed to extend the thanks of the Section to all those who spent their time and effort in planning and arranging the program and entertainment.

II. *Be It Resolved* by the Iowa Section of the American Water Works Association that the Section hereby expresses its appreciation and thanks to its Chairman, J. W. McEvoy and its Secretary, J. J. Hinman, Jr., for their efficient service and constant attention to the interests of the Association.

III. *Be It Resolved* by the Iowa Section of the American Water Works Association that the Secretary, through its Secretary express to the Water Department of the cities of Council Bluffs, Iowa and Omaha, Nebraska the Section's appreciation of the many courtesies extended to them.

IV. *Be It Resolved* by the Iowa Section of the American Water Works Association that the Section desires to express their appreciation to the Manufacturer's Members for their kindness in providing the excellent banquet and fine entertainment enjoyed by the attending members on September 29.

V. *Be It Further Resolved* that the Iowa Section of the American Water Works Association desires that proper stream gaging measurements be maintained in the States in this Section, and to that end asks that the Chairman appoint a committee whose duty it shall be to notify the proper authorities that the members of this Association so desire and will give what assistance they can if called upon. It is suggested that the power companies, state and government engineers, public health officials, and others particuarly interested be notified and asked to coöperate to this end.

The resolutions were adopted.

Mr. Blomquist brought in the following nominations: For Chairman: Thomas J. Skinker; For Vice Chairman: John W. Pray; For Directors: H. V. Pedersen, C. L. Ehrhart.

It was moved, seconded and carried that a unanimous ballot for the nominated men be cast by the Secretary.

In selecting the next meeting place invitations were received from Des Moines, Iowa, Cedar Rapids, Iowa, Marshalltown, Iowa, Sioux Falls, South Dakota, and Kansas City, Missouri. After some discussion it was moved and unanimously carried that the Section recommend to the Executive Committee that the City of Kansas City, Missouri, be selected as the next meeting place of the Section.

A letter from W. M. Niesley, Assistant to the Secretary of the American Water Works Association, was read, giving the numbers of delinquent members in the various states making up the Section.

Attention was called to the fact that the Iowa Section at that time had the smallest number of delinquent members.

A letter from Ernest Boyce, of Lawrence, Kansas, was read in which Mr. Boyce expressed the desire of a number of water works men in Kansas to become affiliated with the Iowa Section, as the number of members in Kansas was insufficient to form a Section there. It was voted that it was the sense of the meeting that the Kansas men should be welcomed into the Section and that the Executive Committee of the American Water Works Association should be requested to extend the territory of the Section to include the State of Kansas.

The further extension of the territory of the Section gave rise to discussion as to the desirability of continuing the present name. It was believed that a new name more descriptive of the territory served should be adopted. It was moved and carried that a questionnaire should be sent to all members of the Section by the Secretary asking for suggestions with regard to names for the Section and that these names be then voted upon by the membership. It was also moved and carried that whatever name was selected the literature of the Section should carry below the new name the designation "Formerly the Iowa Section."

It was moved by Homer V. Knouse that a vote of thanks be given to Mr. Hinman, the Secretary, and that Mr. Hinman's hotel and travelling expenses as Secretary should be borne from the Section funds. The motion was seconded and carried.

Mr. Pedersen, of Marshalltown, moved that when the ballot was taken on the proposed name of the Section a ballot also be taken to determine what dates were considered by the membership as most desirable in view of the exigencies of their work. The motion was carried.

There being no further new business the meeting was adjourned.

At 1:30 p.m. the members again met in the lobby of the Hotel Chieftain and were taken by automobile to the Broadway Pumping Station and River Station of the Council Bluffs City Water Department. Following the visit of inspection a luncheon was served at the Broadway Pumping Station through the courtesy of the Trustees of the Council Bluffs City Water Works. This luncheon, which was arranged by J. C. Hansen, of the Board of Trustees, took place at about five o'clock, enabling the members to take early trains for their homes.

Jack J. Hinman, Jr.,
Secretary.

ABSTRACTS OF WATER WORKS LITERATURE[1]

FRANK HANNAN

Key: American Journal of Public Health, **12**: 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of issue, and 16 to the page of the Journal.

Water Supply Emergency Ordinance Must Stand. Eng. News-Rec., **99**:383, September 8, 1927. Under date of June 12, 1926, State Department of Health notified Fremont, Ohio, that water supply was impure and dangerous, and ordered installation of new supply or purification works. Ordinance providing for filtration was introduced June 15 and adopted June 29. On June 28 an initiative petition was filed with city calling for supply from deep wells already owned by city and such other wells as might be needed. This ordinance was adopted at general election on November 2. Meanwhile, on August 3, City Council passed ordinance providing for construction of filter plant and on September 8 awarded contract for same. Mandamus proceedings were instituted to compel city to drill wells and build accessory works, but Ohio Supreme Court held that, since first ordinance mentioned had been enacted as emergency public health measure, there could be no referendum under state constitution. Opinion indicated further that proper procedure would have been to have applied for referendum on first ordinance instead of instituting proceedings for initiative ordinance.—*R. E. Thompson.*

Water Supply and Sewerage for New Australian Capital. Eng. News-Rec., **99**: 386, September 8, 1927. Water supply of Canberra, the new capital city of Australia which was formally opened in May, 1927, is obtained from Cotter River, 15 miles distant. Water is of good quality and watershed is well protected, being in rough country entirely within the Federal Territory. A 60-foot dam forms 380-m.g. reservoir with safe yield of 7 m.g.d. Dam is designed for future height of 100 feet to give 1400 m.g. storage capacity. Population is 5000.—*R. E. Thompson.*

Winch on Truck Used in Driving Well Casing. WM. E. CLARK. Eng. News-Rec., **99**: 236, August 11, 1927. Brief description of driving of well casing in 700-foot well by means of simple rigging and power winch mounted on truck.—*R. E. Thompson.*

Developing a 6-M.G.D. Water Supply for Oil Field Operations. Eng. News-Rec., **99**: 348–52, September 1, 1927. Detailed illustrated description of water

[1] Vacancies on the abstracting staff occur from time to time. Members desirous of coöperating in this work are earnestly requested to communicate with the chief abstractor, Frank Hannan, 285 Willow Avenue, Toronto 8, Ontario, Canada.

supply system of Phillips Petroleum Co., which serves majority of oil companies in Texas Panhandle field and also the town of Borger. Supply is derived from wells of various types of total capacity of 222,000 barrels per day, another well which will supply 50,000 barrels per day being now under construction. There are 3 main pumping stations, of 40,000 barrels per day capacity each.—*R. E. Thompson.*

Georgia Has 90 Certified Water Supplies. Eng. News-Rec., **99**: 272, August 18, 1927. Of 242 public water supplies in Georgia at close of 1926, 89 were certified safe, 90 were not certified owing to unsanitary conditions, high bacterial counts, or failure to submit sufficient samples, and 63 did not submit samples. For certification by State Board of Health, municipality must keep works in perfect shape and submit monthly samples for examination. Deep well water is supplied by 154 works, filtered water by 47, and spring water by 30. Chlorination is employed at 109 works.—*R. E. Thompson.*

The Snow Report on the Wanaque Aqueduct Controversy. Eng. News-Rec., **99**: 274–6, August 18, 1927. Editorial summary and interpretation of report of F. HERBERT SNOW on Wanaque aqueduct of North Jersey District Water Supply Commission.—*R. E. Thompson.*

Designs for Joints in Large Pipe on Ocean Bottom. Eng. News-Rec., **99**: 294–7, August 25, 1927. Description of 6 types of joints based on experience with Pacific Ocean outfall sewers subject to severe wave action.—*R. E. Thompson.*

Steel Lining for Moffat Tunnel is of Heavy Design. Eng. News-Rec., **99**: 236, August 11, 1927. Brief description.—*R. E. Thompson.*

Ground Water in New Mexico Now Subject to Appropriation. Eng. News-Rec., **99**: 395, September 8, 1927. Act of New Mexico declares that all ground waters of state belong to public and are subject to appropriation for beneficial use under laws relating to appropriation and beneficial use of waters from surface streams. Supervision and control of such underground waters and method of appropriation and use are invested in state engineer. Present use for beneficial purposes is recognized as valid appropriation. Act is not intended to apply to construction of wells by persons, corporations, or municipalities, to obtain water for domestic or stock watering purposes. Act will be administered as to any particular underground source upon petition being presented signed by not less than 10 per cent of all users of such defined source. —*R. E. Thompson.*

Larger Water Supply for Church Community Near Kansas City. C. F. LAMBERT. Eng. News-Rec., **99**: 399, September 8, 1927. Brief illustrated description of new water supply of Unity School of Christianity which consists of concrete dam forming 70-m.g. impounding reservoir, mechanical filter, chlorinating equipment, and elevated tank.—*R. E. Thompson.*

Bristol Dam Designed for Later Height Increase. W. D. HENDERSON. Eng. News-Rec., **99**: 264–7, August 18, 1927. Detailed description of plant built by

Utilities Power Company, at Bristol, N. H., on Pemigewasset River. Dam is reinforced concrete structure of Ambursen type, 520 feet in length. As constructed, normal head is 55 feet, but provision has been made for increase to 80 feet.—*R. E. Thompson.*

Old Masonry Conduit Reinforced to Support Heavy Sand Fill. Joseph Goodman. Eng. News-Rec., **99**: 313, August 25, 1927. Description of reinforcement of brick-lined masonry conduit (8 by 10 feet) and three 48-inch cast iron pipe lines in Brooklyn during construction of boulevard. Data on cracking given which indicate that sand fills of more than 13 feet will probably cause failure of 48-inch cast iron pipe, 1 inch in thickness.—*R. E. Thompson.*

Method for Testing Bond between Concrete and Its Reinforcing. Ross C. Durst. Eng. News-Rec., **99**: 402, 1927. A brief description of a simple method for determining bond between concrete and steel reinforcing consisting of carrying out the test in the usual manner on specimens prepared in pipe sections 3 inches in diameter and 80 inches long. This prevents compression of the concrete which probably exerts a pressure against the rod.—*R. E. Thompson (Courtesy Chem. Abst.).*

Large Hydro Electric Plant at Éguzon, France. L. B. Desbleds. Eng. News-Rec., **99**: 458–61, September 22, 1927. Illustrated description of 75,000-h.p. plant built on Creuse River by Union Hydro-Electrique. Dam is 200 feet high and arched in plan on radius of 820 feet, with base thickness of 177 feet. Total quantity of concrete and stone masonry in dam is 274,000 cubic yards, and capacity of reservoir formed is 1,900,000,000 cubic feet.—*R. E. Thompson.*

A Problem of Municipal Water Supply in the Oil Fields. F. M. Veatch. Eng. News-Rec., **99**: 394–5, September 8, 1927. Previous to oil boom, water supply of El Dorado, Kansas, was obtained from shallow wells, and when these proved inadequate a purification plant was constructed in 1916 to treat Walnut River water. This supply was adequate and of satisfactory quality until oil development extended above city, when pollution by oil wastes increased until abandonment of supply became necessary. Study of Satchel Creek indicated that storage capacity of 785 m.g. would permit continuous draft of 3.5 m.g.d. Contracts were let in January, 1927, for earth-fill dam, spillway, 24-inch cast-iron flow line, and $1\frac{1}{2}$-m.g. clear water reservoir. Total cost will be $288,000, exclusive of land and right-of-way which cost $100,000. Dam is approximately 1900 feet long, with maximum height of 37 feet and crest width of 12 feet. The pipe line, which is 2240 feet long, will deliver water to existing filters, which have nominal capactty of 2 m.g.d.—*R. E. Thompson.*

Self-Damping Gage for Determining Heads in Pipe Lines. D. S. Ellis. Eng. News-Rec., **99**: 478, 1927. A simple modification of the differential head gage which eliminates rapid fluctuations in water level consists in carrying the connecting tube through bottom seal of gage glass nearly to the top, providing a small hole in the tube just inside the bottom seal. Rapid fluctuations in pressure cause the water level in the inner tube to oscillate but as such fluc-

tuations are transmitted to the outer tube only through the small hole at the base of the inner tube the level in the outer tube remains steady and corresponds to the mean pressure in the pipe where that side of the gage is attached. —*R. E. Thompson* (*Courtesy Chem. Abst.*).

Sounding Machine Successfully Used on Hydrographic Surveys. E. W. Lane. Eng. News-Rec., 99: 400, September 8, 1927. Brief illustrated description of sounding machine which has been successfully used on surveys requiring high degree of accuracy.—*R. E. Thompson.*

Controlling Strains on Bronze-Welded Cast Iron Pipe Lines. Eng. News-Rec., 99: 402–3, September 8, 1927. Failures have amounted to less than 1½ per cent of total of 20,000 joints on 50 bronze-welded lines. Investigation of strains in experimental bronze-welded line, 1604 feet long, of 6-inch Class 150 plain end de Lavaud cast iron pipe was carried out by E. Haring, F. G. Outcalt and T. W. Greene. Special care was taken to insure straight jointed sections. Theory, checked by actual measurement, showed that expansion and contraction of buried line held under constraint by friction of backfill varies with square of temperature change. In short sections of 100 feet or less, maximum temperature stress never exceeds 4000 pounds per square inch, which is well within safe strength of material. Expansion joints should therefore be placed approximately every 100 feet. Backfilling, particularly around lower half of pipe, is considered one of most important factors.—*R. E. Thompson.*

Effluent Aërators Control Mechanical Filters. Malcolm Pirnie. Eng. News-Rec., 99: 376–80, 1927. Effluent aërators at the Providence, R. I., West Palm Beach, Fla., Poughkeepsie, N. Y., and Rahway, N. J., filter plants are described and the results attained are tabulated. As a result of aëration the pH values of the waters are increased 0.2–0.3 and the CO_2 contents reduced 1–7.5 p p.m.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

Capacity of Exchequer Reservoir Checked by Flow Record. Eng. News-Rec., 99: 73, July 14, 1927. Curves of capacity at various elevations of Exchequer Reservoir in California computed from estimates made from topographical map during construction of dam and from gagings of inflow and outflow are plotted on same graph. Estimated capacity checks closely with capacity obtained from record of water drawn from reservoir.—*R. E. Thompson.*

Defective Concrete Wingwall Falls at Indianapolis. Eng. News-Rec., 99: 380, September 8, 1927. Brief description of collapse of 50-foot length of riverbank wall on west side of White River on June 20. Wall was originally intended as bank-protection wing downstream of Emerichsville Dam, but had for some time been of no use and abandoned, as new wingwall had been built at dam and new flood-protection apron nearby. Data on condition of concrete included.—*R. E. Thompson.*

Meanderings of Alluvial Rivers Governed by a Fixed Law. P. CLAXTON. Eng. News-Rec., 99: 268, August 18, 1927. Leading principle upon which characteristics of alluvial rivers subject to flood depend is described and discussed.—*R. E. Thompson.*

Floating Waling on Trencher Boom Speeds Wet Job. A. M. RAWN. Eng. News-Rec., 99: 314, August 25, 1927. Brief illustrated description of arrangement for trenching in wet running sand.—*R. E. Thompson.*

Temperature Developed in High-Alumina Concrete. T. H. CUTLER. Eng. News-Rec., 99: 146, 1927. A curve is given showing the temperature developed in high-alumina cement concrete poured when air temperature was slightly below freezing.—*R. E. Thompson (Courtesy Chem. Abst.).*

Everglades Drainage Plan Endorsed with Minor Changes. Eng. News-Rec., 99: 187, August 4, 1927. Chief recommendations of engineering board of review appointed by Everglades Drainage District of Florida to investigate drainage work being carried out.—*R. E. Thompson.*

Tests on Stevenson Creek Dam, Deflections and Stresses. FRED A. NOETZLE. Eng. News-Rec., 99: 66–8, July 14, 1927. Stevenson Creek test dam, completed in June 1925, is 60 feet high and 140 feet long on crest. Upstream radius is 100 feet and thickness 7.5 feet at base and 2 feet at crest. Results of 13 waterload tests carried out during 1926 are summarised.—*R E. Thompson.*

Packed Gumbo Joints in Concrete Reservoir Prevent Leakage. Eng. News-Rec., 99: 71, July 14, 1927. Brief illustrated description of packed gumbo joints between concrete slabs on slopes and bottom of distributing reservoir of Amarillo, Tex. Joints between slabs are tapered from width of about $\frac{3}{4}$ inch at top to $\frac{1}{2}$ inch at bottom. Depth of 1 inch in bottom is filled with calking yarn, remainder of joint being packed with gumbo rammed and compacted with wooden mallet. Gumbo was also used to prevent leakage at expansion joints where reservoir walls are connected with walls of pumping station.—*R. E. Thompson.*

Traveler is Convenient in Placing Sections of 64-Inch Pipe. W. A. KUNIGK. Eng. News-Rec., 99: 71, July 14, 1927. Traveler briefly described and illustrated which has been used several times at Tacoma, Washington, in laying or rebuilding pipe lines where grade was not accessible for derrick or crane work. —*R. E. Thompson.*

Inspection of Water Supplies and Sewage Systems. A. E. BERRY. Pub. Health J. (Can. Pub. Health Assocn.), 18: 339–42, 1927. A general discussion. —*R. E. Thompson (Courtesy Chem. Abst.).*

Movement of Mokelumne Pipe Line During Construction. Eng. News-Rec., 99: 184–7, August 4, 1927. Mokelumne steel pipe, which is 65 inches in diameter for most part and is to be 90 miles long, with shell thickness of $\frac{7}{16}$ to $\frac{1}{4}$

inch, has shop-welded longitudinal seams and was to have girth joints acetylene-welded in field. Welding in field resulted in many breakages (68) and was finally abandoned in favor of riveting. Elaborate investigation of movement of pipe and of stresses involved has been carried out by L. T. Jones and W. S. Weeks, details of which are given. One of most serious stresses was due to large difference in temperature (40°F.) between top and bottom of pipe during daytime. Two important sources of longitudinal stress are present in all, or nearly all, pipe lines, though generally ignored: stress of about one-fourth circumferential water pressure tension, due to Poisson contraction; and stress due to fact that water flowing through pipe in service is colder than pipe at time of construction. Ideal procedure would be to make all joints at night and backfill before following day's temperature rise begins. Data are given on deformations due to progressive heating at joints as welding proceeded and on longitudinal pipe creep. Pipe was in motion for distance of about 40 lengths (30 feet each) back from free end, or, in general, distance in feet equal to about 14 times temperature range (°F.) of top of pipe. Ends of pipe sections that are to be joined, particularly by welding, should be as nearly round as possible and should be permanently deformed if necessary to bring sheets into alignment. Construction on inclines should always proceed uphill in order that gravitational component may oppose inherent residual tension.—*R. E. Thompson.*

Tunneling for City Railway at Sydney, Australia. Eng. News-Rec., **99**: 381–2, September 8, 1927. Illustrated description.—*R. E. Thompson.*

The Au Deep-Well Current Meter for Locating Leaks. Albert G. Fiedler. Eng. News-Rec., **99**: 382–3, 1927. Description of new current meter designed by C. H. Au for detecting and determining the location of leaks in artesian wells and measuring approximately the quantity of water being lost.—*R. E. Thompson (Courtesy Chem. Abst.).*

Report on Chicago's Water Meter Controversy. Eng. News-Rec., **99**: 263, August 18, 1927. In proposed substitute for present universal-metering ordinance at Chicago, it is planned to reduce water consumption for all purposes to 185 gallons per day per capita in 5 years by following means: (1) complete pitometer surveys, (2) underground leak survey, (3) house-to-house inspection, (4) periodical survey and inspections covering previous features, (5) metering every commercial and residential service where assessed rate is $40 or more per annum, or where commercial establishment has service 1½ inches or more in diameter, (6) metering services where there is waste, neglected leakage or unusually large usage. "Probable" distribution of daily per capita consumption at present time is as follows: commercial and industrial, 75; domestic, metered and unmetered, 83; free water, 12; parks, 6; leakage and waste, 109; total 285. It is estimated that commercial item would be reduced to 72 by metering and that leakage and waste would be reduced to 12 by waste-water surveys, making total of 185. Five-year program is proposed, each year to include 40 square miles of new area and resurvey of previous area. Program would begin anew in 6th year. Cost is estimated at $1,280,028 for 1st year and $1,244,028 for each succeeding year, making total of $6,256,140, compared

with total cost of approximately $16,000,000 for universal metering. War Department is favorably inclined. Meters installed in 1926 numbered only 14,851, although 40,000 were required by ordinance. One-third of population is supplied with metered water through 11.6 per cent of services.—*R. E. Thompson.*

Corrosion-Fatigue of Non-Ferrous Metals. D. J. McAdam Jr. Eng. News-Rec., **99**: 95–6, July 21, 1927.—*R. E. Thompson.*

Intermittent Lime Feed Plan Reduces Incrustation from Softened Water. L. C. Billings. Eng. News-Rec., **99**: 70, 1927. Intermittent lime treatment at the 40-m.g.d. plant at Grand Rapids, Mich., has materially reduced carbonate incrustation of mains from lime-softened water and has permitted a reduction in the amount of lime used. The raw water hardness, which is 14 grains per gallon, is reduced 50 per cent by the treatment, which accomplishes the same results as the "split treatment" method, although the resulting water is 2–3 grains per gallon harder than when full lime treatment is employed.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

Combined Railway Bridge and Dam Built at Outlet of Grand Lake, Newfoundland. A. B. McEwen. Eng. News-Rec., **99**: 128–32, July 28, 1927. Detailed description of construction of combined railway bridge and hollow reinforced-concrete dam 1050 feet long and 80 feet high across Junction Brook. Object of dam was to raise level of Grand Lake 25 feet for power development on Deer Lake below. Rock on which dam was built was of very soft porous nature, necessitating extensive grouting.—*R. E. Thompson.*

Torsion Tests of Concrete Cylinders. Eng. News-Rec., **99**: 114, July 21, 1927. Brief details are given of tests of plain and reinforced concrete carried out by Takenosuke Miyamoto of Tokio. Plain cylinders broke immediately at development of first crack, while reinforced cylinders not only reached higher stress at first crack but developed further resistance beyond this point. Various forms of reinforcement were experimented with.—*R. E. Thompson.*

Cement Linings in Irrigation Canals Economic Success. Eng. News-Rec., **99**: 144–5, July 28, 1927. Data given on condition of lining placed several years ago in various parts of system of Imperial Irrigation District in California. In one case maintenance costs were reduced from $500 per mile per year to $15 per mile per year by placing of lining which cost about $8,000 per mile.—*R. E. Thompson.*

Industrial Waste Disposal. A Symposium. Proc. Am. Soc. Civ. Eng., **53**: 7, 1649–1712, September, 1927. **Introduction.** W. L. Stevenson. The conservation of water resources is of importance to the health and prosperity of the people. Life in modern cities is impossible without adequate public water supplies, and the protection and promotion of the public health demand that such water be pure and palatable. Water unimpaired in quality was practicable everywhere in this country when it was first settled, but modern civilization with sewered cities and industries has completely changed the

primitive conditions which existed in the days of the pioneer. Conservation is intended to render the water resources increasingly useful, but it is not intended to return them to a state of pristine purity or to stop all unpurified wastes being discharged into them. **Treatment of Wastes from Oil Refineries.** R. S. Weston. Much water is used for cooling, various petroleum products are treated with chemicals and washed with water, and there are leakages containing the oil and oily products. The chief factors in the purification of refinery wastes are gravity and time. A satisfactory treatment works should discharge an effluent practically free from settleable solids and containing less than 20 parts per million of oily matter. **Disposal of Drainage from Coal Mines.** A. B. Crichton. Practically all coal-mine drainage contains sulfuric acid. The natural alkalinity of fresh-water streams will neutralize large quantities of mine water, but as it requires 80 to 100 gallons of fresh water to neutralize 1 gallon of average mine water that dilution is not long effective in mining regions. The neutralization of acid mine water by the introduction of lime does not make the water suitable for either domestic or industrial use. Analyses of several mine waste-waters show a total acidity of from 61 to 169 grains per gallon. After the decree of the Court in the Indian Creek case was made effective, three of the mining companies built plants to neutralize the mine water by the introduction of hydrated lime. This is very expensive and unsatisfactory. The cost of neutralizing mine water is estimated at 15 to 25 cents per 1000 gallons. With an average annual production of 160,000,000 tons in the bituminous fields of Pennsylvania, the cost will be from 26 to 43 cents per ton for neutralizing, and from 50 to 90 cents per ton for softening. There is no satisfactory method of treating acid mine waters in quantities by the mines of the United States. **Pulp and Paper Mill Wastes.** G. K. Spence. More than 8,000,000 tons of pulp, paper, and paper-board are annually made in this country, which output is valued at more than $900,000,000. Finely divided particles of bark, sawdust, black ash residue from the soda pulp mills and entrained fibers from various steps in the manufacture of pulp and paper have a tendency to increase the turbidity, and render the stream less pleasing to the sight. Spent liquor from sulfite mills will have a tendency to impart a brown color to the stream. Lime sludge when discharged into the stream will increase the turbidity and hardness of the water. Very little is known relative to the amount of pulp and paper mill effluent a stream of a given flow can inoffensively assimilate. The pulp and paper companies, through their research departments, have spent millions in developing uses for, and devising means of disposal of, waste materials from the mills. Known methods for the elimination of waste include burning the bark and sawdust. Dust from the rag department has found a market with manufacturers of roofing paper and other similar products. Improvements have been made in the methods of washing brown stock in soda pulp mills so that the quantity entering the streams has been reduced. Waste water from the brown and white stock thickeners in rag, mechanical wood, sulfite, soda, and sulfate pulp mills is being passed to efficient save-alls where as much as 98 per cent of the suspended fiber is being removed before passing the water to the stream. More money has been spent and more research work conducted to find methods for the disposal of waste sulfite liquor than on any other pulp or paper mill waste, and it is still

one of the unsolved problems. **Studies on Tannery Waste Disposal.** W. Howalt and E. S. Cavett. The authors present the results obtained in a two-year investigation of the disposal of tannery wastes. The wastes used were produced by a medium sized sole leather tannery at which the vegetable tanning process was used. The authors describe in detail the kind of wastes produced and the results of their investigation. Treatment with sulfuric acid seemed to be the most promising. An experimental plant was constructed. The waste liquors were run into a tank and enough sulfuric acid added to produce a pH of 5.5. The mixture in the tank was permitted to settle quietly over night, and the next morning the supernatant was started discharging at an even rate and for 8 hours thereafter. Mixing certain wastes and prolonging their discharge could be used to advantage at some places.—*John R. Baylis.*

Earth Work by the Hydraulic Method. R. E. Miller. Proc. Am. Soc. Civ. Eng., **53**: 7, 1713–19, September, 1927. The character of the soil is the controlling factor in the cost of the work where material is to be excavated and placed by hydraulic dredging or by sluicing. The most important element in a soil, as affecting its ease or difficulty of working, is the clay content with its specific properties. Particles less than 0.001 mm. diameter are classified as clay. Between 0.001 mm. and 0.01 mm. the particles are classified as silt, and over this diameter, as sand or gravel. The laboratory work has been found of great help in estimating the cost of handling the material.—*John R. Baylis.*

Problems in Concrete Dam Construction on the Pacific Coast. A. S. Bent. Proc. Am. Soc. Civ. Eng., **53**: 7, 1722–6, September, 1927. No two dams are alike and no one plan of operation is the optimum for more than a single location. The author describes the variables that have to be taken into consideration in estimating the costs at different locations.—*John R. Baylis.*

New Theory for the Centrifugal Pump. A. F. Scherzer. Proc. Am. Soc. Civ. Eng., **53**: 8, 1775–1803, October, 1927. The actual design of a centrifugal pump is based largely on the known performance of similar pumps. The pump gives a head of only $\frac{U_a^2}{2g}$ at "shut off" instead of $\frac{U_a^2}{g}$ as required by all present theories for the simple reason that this is all the energy. U_a is the peripheral speed of the runner at its outer diameter, and g is the acceleration due to gravity. Equations used for present theories do not furnish a rational basis for the analysis and design of centrifugal pumps. The water contained in the impeller rotates with it and owing to centrifugal force has a tendency to move out from the center. The flow from the runner is due to the difference between the force tending to throw the water out and the pressure in the casing tending to hold the water in the runner. This entirely prevents the free radial acceleration necessary to obtain the theoretical $\frac{V_2^2}{g}$ so often given in texts. Guide-vanes are not necessary. The volute casing is supposed to permit the efficient conversion of velocity into pressure through the recovery of a part of

the energy represented by the absolute velocity of discharge from the runner. The velocity is converted into pressure in the casing, but it is not all in the manner or for the reasons usually given. Apparently, the only function of the casing is to restrain the water and to compel it to move in a circular path. The pressure exists only because of the velocity. It is hopeless to expect any gain from the use of guide-vanes and spiral casings, since their advantage is based on conditions which can easily be proved never to have existed. A 4-inch pump was designed and built in accordance with the new ideas. It differed to a marked degree in the design of the various hydraulic details. It was a single-stage pump with neither volute nor guide-vanes. The runner was set concentrically in a casing of constant circular cross-section. A maximum efficiency of 79 per cent at a capacity of 330 gallons per minute and a head of 67 feet at 1450 revolutions per minute was developed. The extreme flatness of the efficiency curve indicates that it has been possible to develop extremely high efficiencies without any sacrifice of other desirable features. A number of equations are given.—*John R. Baylis.*

The Influence of Hygrogen Ion Concentration on the Dose of Alum and the Mechanism of the Action of Alum in the Clarification of Natural Waters. N. L. BANERJI. Indian Jour. Med. Research, 11 (1924), No. 3, pp. 695–718. Experiment Station Record, U. S. Department of Agriculture, **54**: 4, 383, March, 1926. "Studies are conducted which showed that with other factors, such as suspended matter, size of particles, and concentration of electrolytes remaining constant, the optimum dose of alum for water clarification increases and decreases with the pH, and that total hardness is an important factor in regulating the dose. The mechanism of the action of aluminum sulfate is divided into two portions due to unhydrolyzed aluminum sulfate and hydrolyzed aluminum sulfate. The positive aluminum from the unhydrolyzed portion is the most potent factor in clarification. The dose of alum can be decreased by the preliminary addition of sulfuric acid. This is considerd to be very important from the standpoint of economy in water clarification in the case of slow sand filters when the suspended matter in river water is very high."—*A. W. Blohm* (*Courtesy S. P. H. Eng. Abst.*).

Some Further Observations on the Species Method of Differentiating Fecal Organisms in Surface Waters in the Tropics. A. D. STEWART and V. G. RAJU. Indian Jour. Med. Research, 11 (1924), No. 4, pp. 1157–1162. Experiment Station Record, U. S. Department of Agriculture, **54**: 4, 383, March, 1926. "Studies are reported which showed that B. coli communis is a very common organism in human feces, forming 29 per cent of the fecal organisms present and 26 per cent of those in septic tank latrine effluents. The number of B. coli communis isolated from stored water were in marked contrast to those obtained from human feces, in spite of the fact that several of the samples examined had only a short period of storage. B. coli communis formed only 8 per cent as against 29 per cent in human feces, 26 per cent in septic tank latrine effluents, and 20 per cent in typically polluted river water. B. Neapolitanus formed 37 per cent as against 32 per cent in crude human feces and 28 per cent in latrine effluents. This is taken to indicate that this organism is not adversely affected

by storage, and consequently is found in stored waters in equal or greater number than in freshly polluted waters or crude human feces. B. coli communis was not found at all in any of the waters subjected to prolonged storage, in spite of the fact that it was a predominating organism at the start.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Algal Growths in Tank Waters and the Effect on them of the Removal of the Dissolved Bicarbonates of the Water by the Addition of Sulphuric Acid. V. G. Raju. Indian Jour. Med. Research, 11 (1924), No. 4, pp. 1057–1063. Experiment Station Record, U. S. Department of Agriculture, **54**:4, 382, March, 1926. "It is stated that many of the tank waters in Bengal are rendered unfit for drinking by the growth and subsequent decay of algae. The chief causes of their presence are the accumulation of algal spores and resistant forms in the debris at the bottom and sides of the tank, the presence of bicarbonates in the tank water, a certain amount of quiescence and transparency in the water, and a suitable atmospheric temperature."—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

The Stability of Solid Calcium Hypochlorite. H. H. King. Central Research Institute, Kasauli. Journal of the Royal Army Medical Corps, **46**: 6, 438, June, 1926. Experiments on concentration and stability of solid calcium hypochlorite made in India by the writer. The hypochlorite, a German preparation, was forwarded from England in November, 1923, and tested in February, 1924.

Amounts of Soap and Builder Necessary to Soften Water of Different Degrees of Hardness. H. B. Robbins, H. J. MacMillan and L. W. Bosart. Indust. and Eng. Chem., **18**: 1, 27, January, 1926. The cost of softening water with a built soap in which soda ash is the builder is practically independent of the proportion of builder which the soap contains. The amount of soda ash to add for waters of different degrees of hardness in order to arrive at the minimum cost for producing suds is shown. With water of zero hardness there is no practical difference in the cost of treatment whether a built soap is used or the soda ash is added first and then the soap.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

New Water Supply for Athens and Piraeus, Greece. Adolph G. Wulff. The American City Magazine, **34**: 6, 607, June, 1926. Within a few years the cities of Athens and Piraeus in Greece, which have been supplied with water through aqueducts that were built by the ancients and that are now inadequate, will have a new works built by Americans. The improvements consist of a large reservoir, a complete distribution system, and a salt-water supply for sprinkling and fire protection. The works will cost $11,000,000. It is of interest to note that the amount of water available at the present is 5 gallons per capita and that the new works will supply about 45 gallons per capita.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Sterilization of Water. Ryukichi Joh. Journal of the Public Health Association of Japan, **2:** 4, 4, April, 1926. The use of bleaching powder was first introduced in Kagawa Prefecture in 1912 as an experiment, and subsequently it was used extensively in 1919 throughout dysentery-stricken areas in the prefecture. Of the various methods for the chemical sterilization of drinking water practised at present, chlorination is the best in every respect. The complaints of people against the use of chlorine when bleaching powder has been thrown into wells, due to odors and turbidity caused by the production of carbonate of lime, can be avoided by the use of chlorine in the form of hypochlorous acid. An additional advantage is that hypochlorous acid is stronger than the same quantity of bleaching powder. It can be prepared any time, at any place, and in an easier way than bleaching powder.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

The Water Works of Bellefonte, Pennsylvania. James D. Siebert. American City, **34:** 6, 605, June, 1926. A brief description of the municipal water supply is given, the origin being a spring which supplies about 8000 gallons of water per minute. The flow and the 50°F. temperature of the water remain constant throughout the year. A 300,000-gallon reservoir is connected to the system. An interesting feature of the power station is the use of an old turbine water wheel, built in 1870.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*)

Some of the Results Attained through Federal Supervision of Water Supplies used in Interstate Traffic. A. F. Allen. Texas State Journal of Medicine, **22:** 3, 189, July, 1926. After briefly reviewing the historical development of the present certification procedure of water used in interstate traffic, the author treats of the increase in number of supplies requiring certification, due to the decision in 1921 that a carrier is subject to the Interstate Quarantine Regulations, under certain conditions, and the classification in 1922 of vessels as well as railroads as common carriers.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Sterilization of Water by Liquid Chlorine. J. M. Mathew. The Commonwealth Engineer (Australia), **13:** 1, 30, August 1, 1925. An account and description of equipment is given of what appears to be the first use of liquid chlorine for the treatment of a public water supply in Australia.—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Storage of Drinking Water Considered as a Means of Purification. Schaefer. Revue d'Hygiene, **47:** 12, December, 1925, p. 1167 (in French). Office International d'Hygiene Publique, **18:** 5, 578, May, 1926. Conflicting evidence on the survival of pathogenic bacteria in water in general, but the author concludes that under normal conditions of temperature, organic matter and degree of acidity, the pathogenic bacteria disappear for the most part in 8 days and those remaining are dispersed and attenuated so as to be inoffensive. Certain precautions are necessary in reservoir construction, such as, steep sides to prevent growth of grass and vegetation, a smooth bottom to prevent deposition of organic matter in the depressions, as this aids in the growth of

certain algae with noticeable odors. If such conditions of algae growth occur relief is had by the use of copper sulphate (from 2 to 10 pounds per million gallons or potassium permanganate (2.5 to 5 pounds per million gallons).—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Effect of Water Containing Free Chlorine in Bread Making. C. B. MORISON. Cereal Chem. 1924, v. i, 267–72. (Summary taken from Exper. Station Rec., 1925, v. 53, 161). Bulletin of Hygiene, **1**: 3, 180, March, 1926. "The results of uniform baking tests with ingredients varying only in the amount of free chlorine in the water are reported and indicate that the presence of from 5 to 10 parts of free chlorine per million has no deleterious effect on bread quality. Since these amounts are from 12 to 15 times the maximum amount of residual chlorine that has been found in the Chicago water supply, complaints that the chlorination of water in that city is detrimental to the quality of bread prepared with it would seem to be unfounded. The fermentation power of fresh yeast was also found to be unaffected by the presence of five parts per million of chlorine in the water."—*A. W. Blohm* (*Courtesy U. S. P. H. Eng. Abst.*).

Arsenic Content of Streams. WALTER ROTH. Ind. Eng. Chem. News Edn., **5**: 21, 7, 10, October, 1927. Arising from the so-called Haff sickness, a satisfactory explanation of which is still lacking, investigations by Prof. GOY and collaborators have disclosed an As_2O_3 content of 5 to 10 parts per billion in the fresh water Haff and of 2 to 4 parts in other East Prussian fresh waters. This is regarded as naturally occurring and not as caused by wastes. In the Baltic itself, along the coast, from 1 to 2 parts per billion are found. The bottom silts of these waters are still richer in arsenic, the dry substance containing 2 to 5 parts per million of As_2O_3. It is thought that this accumulation was more probably effected by microörganisms taking up arsenic from the water and sinking to the bottom at death than by precipitation of the arsenic as sulphide. —*Frank Hannan.*

Sterilization of Drinking Water. CHARLES LORMAND. Ind. and Eng. Chem., News Edition, **5**: 22, 6, November 20, 1927. In new method of CHEVRIER and SALLES, the naturally occurring chloride of the water is utilized as the source of electrolytic chlorine for sterilization. A very fine platinum wire is used as anode and a large metallic surface as cathode; a convenient arrangement being a metallic cylinder with the anode at its axis. The water passes through this cylinder of small cross section. Sterilization is adequate, continuous, and easily controlled.—*Frank Hannan.*

Indiana Stream Pollution Act. Monthly Bulletin, Indiana State Board of Health, **30**: 3, 38, March, 1927. An act of Indiana legislature, approved March 3, 1927, makes it unlawful to drain into any water "dyestuff, acid, coal tar, oil, logwood, or any other poisonous substance, which of itself is deleterious to public health or industry." State Board of Health is given power to order abatement of any violation. Each day's violation is subject to fine of $25 to $200.—*G. C. Houser.*

Camp Sanitation. C. R. Cox, Public Health News (N. J. Department of Health), **12**: 5, 114, April, 1927. Camps often use dual water supplies, consisting of well or spring as source of potable water, and of lake or stream as source of water for general purposes. This arrangement leads to consumption of water not intended for potable purposes, when such water is clear and has a satisfactory taste. Therefore use of dual water supplies is not advisable, unless both waters are of safe sanitary quality.—*G. C. Houser.*

Typhoid Fever. E. D. Rich. Michigan Public Health, **15**: 5, 79, May, 1927. In 1913 about 30 per cent of the population of Michigan was furnished with treated water, and the annual typhoid deaths in the state amounted to 17.4 per 100,000 population. At present 59 per cent of the population is supplied with treated water; typhoid death rate for 1926 was 2.8. Improved water supplies have been dominant factor in reducing ravages of this disease.—*G. C. Houser.*

The Cause of a Belated Protest. Public Health News (N. J. Department of Health), **12**: 6, 161, May, 1927. In September 1926, the State Department of Health granted Borough of Tenafly permission to erect a sewage disposal plant, the effluent from which was to be discharged into a tributary of Hackensack River above intake of Hackensack Water Co. After award of construction contract, residents of Teaneck protested against installation of sewage plant. This belated protest was made because a company in New York, manufacturing an alcohol denaturant, had poured its wastes into a tributary of Hackensack River, affecting taste of water.—*G. C. Houser.*

Typhoid and Water Supply. C.-E. A. Winslow. Michigan Public Health, **15**: 6, 101, June, 1927. Where public water supplies are not properly protected, heavy rains and melting snows are apt to wash infective material into a reservoir. This happened in October 1926, at Akron, N. Y., where failure properly to operate purification plant caused over 200 cases of typhoid in a village of 2,000 inhabitants.—Of the 77 large cities in the United States, 30 had typhoid rates below 2 per 100,000 in 1925, while 2 cities had rates over 20.—*G. C. Houser.*

Act Concerning Pollution of Waterways by Garbage and Refuse. Connecticut Health Bulletin, **41**: 6, 129, June, 1927. Recent act of Connecticut legislature provides that no person or corporation shall deposit any garbage or domestic refuse in any river, stream, pond, lake, or tidal waters, unless granted a permit by state water commission. Violation is subject to fine of not more than $200. —*G. C. Houser.*

Water Meter System Installed in Luray, Va. Virginia Municipal Review, **4**: 6, 187, June, 1927. Town council of Luray has decided to make the water system self-sustaining by installation of meters. Rates are as follows: $.40 per 1000 gallons when 10,000 gallons are used; $.30 per 1000 gallons when 15,000 gallons are used; $.20 per 1000 gallons when 25,000 gallons are used; $.15 per 1000 gallons when 50,000 gallons are used. All users of water outside the corporate limits are charged double rates.—*G. C. Houser.*

ABSTRACTS, SUB-COMMITTEE NO. 9

JOINT RESEARCH COMMITTEE ON BOILER FEEDWATER STUDIES

Notes on Water Analysis. D. BURTON and J. K. HASLAM. Chem. and Industry, **46**: 12, March 25, 1927, pp. 111T-111T. Draws attention to several points in analysis of boiler feed waters, which is of moment to all industries.

Feed Water and Feed-Water Apparatus. Log, **9**: 2, May 1927, pp. 20–28. Care and test of water and operation, care, and repair of equipment, as advocated by manual of engineering instructions.

Some Observations on Priming and Foaming. CYRUS WM. RICE. Power, **65**: 15, April 12, 1927, pp. 544–546, 4 figs. Priming and foaming defined; effect of rating on impurities in steam; effect of high water and sharp variations in boiler load; safe concentrations for various types of boilers at various ratings; practical operating rules.

Feedwater Treatment for High-Pressure Boilers (Speisewasserversorgung der Hochdruckkessel). V. RODT. *Zeit. des Bayerischen Revisions-Vereins*, **31**: 1, January 15, 1927, pp. 5–6. Points out that large amount of salt which must be removed from feedwater for high-pressure boilers can not be extracted by any chemical purification process; turbine exhaust steam and condensation water are used as feedwater, but remaining additional water must be obtained by thermal treatment, that is, precipitation of water from steam; with this process it is necessary to evaporate water economically with exhaust steam, and in condensation of this water heat of condensing steam must be utilized for preheating of feedwater; systems of this kind have already been developed by different firms.

Impurities in Feed Water and Their Effect on Boiler Operation. J. B. ROMER. Power; **66**: 1, July 5, 1927, pp. 32–33. Minerals in boiler water; effects of various minerals on boiler operation; corrosion; abstract of paper read before American Water Works Association.

New Process for Removing Oils from Condensation Water for Use as Feedwater and for Making Crystal Ice (Neues Verfahren zur Entölung von Dampfwasser für Kesselspeisung und zur Herstellung von Kristalleis), E. SANDHERR. Wärme- u. Kälte-Technik, **29**: 11, June 1, 1927, pp. 141–143, 2 figs. Description of DYXHORN process, patented in Holland, for skimming, filtering, and chemical treatment of water of condensation to remove oils from it; system of making ice as by-product, employing exhaust steam.

An Instrument for Recording Dissolved Oxygen in Feed Water. Eng. and Boiler House Rev., **40**: 12, June 1927, pp. 621–624, 2 figs. Patent recorder is robust boiler-house instrument, which records percentage of oxygen on chart calibrated in cubic centimeters per liter of water, and thus enables defects in feedwater system to be instantly detected.

The Purification of Water for Boiler Feed Purposes. T. R. DUGGAN. Eng. Inst. Canada—Jl., 10: 8, August 1927, pp. 379–385, 6 figs. Review of the various methods of water purification. Paper read before Montreal Branch of The Engineering Institute of Canada, March 10, 1927.

Crockatt's Electric Salinometers. Machy. Market, no. 1376, March 18, 1927, p. 23, 3 figs. Patented instrument which continously and automatically records degree of salinity of feedwater; all that is necessary is to connect feedwater supply to electrode cell and lead from lighting mains to electrical circuit.

Lime-Soda Diagram as Aid in Feedwater Treatment (K-S-Wasserdiagramm als Hilfsmittel bei der Wasserpflege). I. W. ARBATSKY. Wärme, 50: 19 and 20, May 13 and 20, 1927, pp. 329–353, 10 figs. Criticizes present day criterion based on hardness of water, saying it leads to wrong results and gives no suggestion as to method of purification; presents new criterion based on lime-soda relationship, also diagrams for solving problem of this kind and describes special apparatus designed for testing waters on basis of new criterion.

Factors Bearing on Proper Water Treatment. D. C. CARMICHAEL. Power Plant Eng., 31: 9, May 1, 1927, pp. 505–509, 7 figs. Analysis of data collected in three plants to determine most important factors to be considered in treatment of feed water.

Feedwater for World's Largest Boilers Receives Zeolite and Acid Treatment. Power, 66: 3, July 19, 1927, pp. 90–94, 5 figs. To prevent scale formation in boilers operating at 300 per cent rating when fed with 90 per cent makeup, zeolite softening was selected and is followed by treatment with sulphuric acid, to reduce high caustic alkalinity in zeolite water.

Feed-Water Treatment. Elec. West, 58: 6, May 15, 1927, pp. 389–392. Methods employed by Southern Pacific Co.; Mare Island navy yard; Great Western Power Company; Pacific Gas & Electric Company; Southern California Edison Company Long Beach Steam Plant; Los Angeles Gas & Electric Corporation; San Joaquin Light & Power Corporation. Prime Movers Committee Report to Pacific Coast Electric Engineers.

Preliminary Purification of Boiler Feedwater (L'épuration préalable de l'eau d'alimentation des générateurs), M. J. GUTH. Assns. Françaises de Propriétaires d'Appareils à Vapeur—Bul., 28: April, 1927, pp. 136–146, 5 figs. Discusses elimination of scale-forming salts and other harmful elements from feedwater before it enters boiler; physical, chemical and combined physico-chemical process.

Some Notes on Feed Water Treatment. A. SETON. Eng. & Boiler House Rev., 40: 11, May, 1927, pp. 569–570. Most of failures which are recorded are directly due to water and its dissolved constituents, including gases and oil in suspension; ideal plan, which is not always practicable is to condense all steam after use, and to use condensate as makeup; under best conditions 90 per cent of steam generated may be recovered in this way; softening of boiler water.

Treating of Water for Boiler Feed Pays Handsome Dividends. F. B. Good. Nat. Petroleum News, **19**: 21, May 25, 1927, pp. 59–62. Deals with different systems of treatment.

Boiler Corrosion and Pitting. Boiler Maker, **27**: 5, May 1927, pp. 138–139. In its search for information as to progress in combating evils of pitting and corrosion, committee sent out questionnaire to which 39 replies were received. Abstract of report presented to Master Boiler Makers' Association.

Cause of Dangerous Boiler Deterioration. C. E. Stromeyer. Power, **65**: no. 17, April, 26, 1927, pp. 648–649. Prominence is given to uniform wasting, which is most misleading and dangerous corrosion to be met with in boilers, and has been cause of many disastrous explosions; incrustation; causes of failures of apparently sound plates, prominence being given to possibility of caustic embrittlement. Abstract of 1926 report of Manchester Steam Users' Association of England.

Boiler Failures. Engineering, 123, 3199, May 6, 1927, pp. 552–553. Review of memorandum by C. E. Stromeyer in which he gives list of exhibits in his museum and valuable comments upon them; prominence is given to subject of uniform wasting; case of scale falling off two furnaces of Lancashire boiler and forming bed of loose sediment on front end of shell; introduction of caustic soda or carbonate into boilers for anti-corrosion or anti-scale purposes is generally accepted as almost certain cause of failure, owing to embrittling action of these substances.

Boiler Scale Prevention by an Entirely New Method. Eng. and Boiler House Rev., **40**: 12, June 1927, pp. 628–630. Process, known as "Etherium" scale-treatment method, consists of specially prepared compound, which is placed inside sealed metal canisters, and these canisters are placed in feed-water tank; peculiarity of this special compound is that although not in contact with water, it changes nature of solid contents of water, both those in suspension and in solution, such change having effect of preventing solids from forming scale inside boiler.

Some Investigations into the Cause of Erosion of the Tubes of Surface Condensors. C. A. Parsons. Shipbldg. and Shipg. Rec., **29**: 15, April 14, 1927, pp. 412–416, and (discussion) 446–449, 6 figs. Account of experimental investigations designed to throw light upon actual conditions attending regional disturbances in water box, and manner in which they affect character of flow through tubes in their vicinity, also to investigate possibility that pitting of condenser tubes may in reality be due to water-hammer of collapsing vortices, which is known to be potent cause of erosion of screw propellers and of impellers of centrifugal pumps and water turbines. Abstract of paper read at Instn. Nav. Architects, April 6, See also Engineer, **143**: 3717, April 8, 1927, pp. 390–391, 8 figs.

Differential Aëration Corrosion Theory. W. B. Lewis, and G. S. Irving. Eng. and Boiler House Rev., **40**: 11, May 1927. pp. 583–584. Water-level cor-

rosion; factors which influence corrosion; calcium nitrate, calcium chloride, magnesium chloride, magnesium nitrate, carbonic-acid gas and oxygen, are chief corrosive substances in boiler feedwaters, and it is their influence and effect which have to be neutralized if corrosion is to be prevented.

Corrosion (Reichsausschuss für Metallschutz). Zeit. für angewandte Chemie, **40**: 3, January 20, 1927, pp. 96–103. Symposium of papers at 1926 meeting of Reichsausschuss für Metallschutz, as follows: **Corrosion Research in England,** M. Haas; **Rust Damage and Protection Costs,** W. Widderholt; **Stainless Steels,** Strauss; **Estimating Rate of Rusting and Rusting Tendency, Especially of Cr Steels,** Duffek; **Aluminum Corrosion,** E. Maas; **Nomenclature of Tars and Bitumens;** Mallisson; **Waters Which Attack Metals and Cement,** Klut; **Corrosion and Practical Boiler Operation,** A. Splittgerber; **Colloid Chemistry and Corrosion Research,** Beck; **Theory of Surface Coatings,** A. Blom; **Storch-Morawski Reaction,** H. Wolff; **Corrosion Protection by Coatings,** O. Jäger; **Standardization,** K. Wuerth; **Chemical Behavior and Overvoltage of Metals,** F. Liebreich; **Cable Corrosion,** O. Haehnel; **Light Aircraft Alloy Corrosion,** Rackwitz.

Prevention of Corrosion in Steel Pipe Line. W. K. Weller. Water Works, **66**: 7, August 1927, pp. 342–343, 1 fig. How deaëration process is used on 350 mile line in Western Australia described in paper presented February 27 at annual conference of Institution of Engineers, Australia.

Peculiar Failure of Steel Water Pipe. J. W. Hall. Water Works, **46**: 7, July 1927, p. 265. General conditions, the causes of failure, and remedy.

Chemistry of Water Softening Simply Explained. Eng. and Boiler House Rev., **40**: 12, June 1927, pp. 616–618. Attempt is made to give essential facts relating to main chemical reactions involved in purification of boiler feedwater, especially as regards elimination of scale.

The Porter Water Softener, J. Mills & Co., Mech. World, **81**: 2112, June 24, 1927, pp. 449–450, 3 figs. Cold-process softener supplying 2500 gallons per hour of boiler feed-water for Radcliffe mill; sufficient lime and soda ash to last from 8 to 12 hours is dissolved in lime-mixer.

Use of Lime in Water Softening and Water Purification. C. P. Hoover, Pit & Quarry, **14**: 5, June 8, 1927, pp. 59–63, Addition of lime to water not only softens it, but, when added in sufficient quantity to produce residual or excess lime, caustic alkalinity, kills intestinal and pathogenic bacteria, rendering water safe bacterially.

Recent Developments in Zeolite Softening. A. S. Behrman. Indus. and Eng. Chem., 19, 4, April 1927, pp. 445–447, 3 figs. Demands upon modern zeolite water softener are considerably more exacting than those made on its predecessors; chief among these are greater softening capacity per given

volume of zeolite, more rapid rate of base exchange, and minimum loss of water pressure through zeolite bed; distinct advance has been made possible by development of synthetic "gel" type of zeolite, which is principal subject discussed.

Apparatus for Deaërating Boiler Feed Water. R. C. Jones. U. S. 1,622,283, March 29. Chem. Abstracts, May 20, 1927, **21**: 1687

Apparatus for Distilling Boiler Feed-Water. Akt.-Ges. Brown, Boveri, et Cie. Brit. 255,050, July 9, 1925. Chem. Abstracts, August 20, 1927, **21**: 2752.

Complete De-Oiling of (Boiler) Feed Water. Aluminum Hydroxide as a Filtering Medium. Anon. Apparatebau **39**: 161–2 (1927). Chem. Abstracts, September 10, 1927, **21**: 2948. A little freshly precipitated $Al(OH)_3$ added in the last section of the separating tank before the filter removes all of the oil. —*J. H. Moore.*

Degassing Feed-Water for Boilers. Ges, P. Müller. Brit. 254,707, July 3, 1925. Chem. Abstracts, August 20, 1927, **21**: 2752. An ejector for creating a partial vacuum on the feed H_2O is fed with steam generated by reducing the pressure on H_2O from the boiler.

Distilling Boiler-Feed Water with Exhaust Steam. A. Meyer. Brit. 256,199 July 31, 1925. Chem. Abstracts, September 10, 1927, **21**: 2949.

Factors Bearing on Proper Feed Water Treatment. D. C. Carmichael. Power Plant Engineering, **31**: 752, 1927; cf. C. A. **21**: 2344. Chem. Abstracts, August 10, 1927, **21**: 2518. The determination of the quantity of oil in steam is carried out by extracting the oil from the condensed steam with ether, evaporating the ether extraction in a tared vessel to constant weight at 90°, and weighing. When suspended matter is present, $FeCl_3$ and NH_4OH are used to precipitate the suspended matter and oil. After suspended matter and oil are filtered, the filter is dried at 90°; the oil is extracted from the precipitate with ether in a Soxhlet apparatus. From this point the determination is carried out as above.—*S. D. Poarch.*

Impure Water Factor in Corrosion. Peters, Otto. Oil and Gas J., **25**: 45, 168 (1927). Chem. Abstracts, August 20, 1927, **21**: 2751. Boiler water is treated with a solution made by diluting 120 pounds lime with 150 pounds soda ash and adding 15 pounds alum in 4 barrels mixture which is fed into the chemical tank at a rate taking 24 hours.—*M. B. Hart.*

Preventing and Removing Scale from Water. P. Schenitza. U. S. 1,617,350, February 15, Chem. Abstracts **21**: 1161, April 10, 1927. A composition for preventing and removing scale is formed from a resin such as colophony mixed with a protective colloid, e.g., gum arabic, and with borax, waterglass, and ultramarine.

Preventing Scale Formation from Water in Boilers. T. McDermott. Brit. 251,122, May 29, 1927. Chem. Abstracts, April 20, 1927, **21**: 1321. Soda crystals are added to the feed H_2O to render it alkaline and a perforated wood receptacle containing compressed swede turnip root with or without the addition of cabbage and heather chopped fine is suspended in the boiler.

A Problem in Boiler Corrosion. H. G. Denham. Trans. Proc. New Zealand Inst. **57**: 900–1. 1927. Chem. Abstracts, August 10, 1927, **21**: 2518. The excessive corrosion of boiler tubes was found to be due to the presence of 2.52 grains per Imperial gallon of silica in the feed water. It was further enhanced by high concentrations of Ca and Mg salts. From the analytical data given, a formula for treating the feed water was calculated. A mixture of 2½ pounds of soda ash and 1½ pounds NaOH per 10,000 gallons of feed entirely eliminated the corrosion.—*J. N. W.*

Removal of Gas From Boiler Feed Water. Töller, W. Z. angew. Chem. **40**: 260–2, 1927. Chem. Abstracts, June 20, 1927, **21**: 2040. In the absence of other substances, like $MgCl_2$, which cause corrosion, O and CO_2 are considered the causes. CO_2 gives H and Fe is dissolved. O serves to depolarize, changing Fe^{ii} to Fe^{iii}. Addition of alkali is helpful. Removal of O by chemicals is helpful, but expensive. The gases may be removed by mechanical and chemical means. Mechanical means, even with heat are difficult. Chemical means, using Fe filings or turnings in a filter, are the best for gas removal. Na_2SO_3 might be used, but the sulfate formed increases the concentration of soluble salts in the boiler.—*Edward Bartow.*

The Scientific Treatment of Boiler Feed Water, Introducing the Colloidal Aspect. Lewis, W. B. and Irving, G. S. Trans. Ceram. Soc. (England) **25**: 200–5, 1926, Chem. Abstracts, June 10, 1927, **21**: 1860. A general discussion of corrosion and incrustation difficulties in boiler waters.

Thermal Preparation of Boiler Feed Water. Blaum, R. Z. Ver. deut. Ing. **71**: 285–90, 1927. Chem. Abstracts, June 10, 1927, **21**: 1860. Feed water for boilers is deaërated by means of a vacuum evaporator. On shipboard all exhaust steam is used for preheating, or for evaporating more water to make up loss, and is finally condensed and used for feed water. On shore installations, similar use is made but here the apparatus need not be so compact. Several types made by the Barart Atlas Works are illustrated by schematic diagrams and are said to be quite efficient. These consist of multi-stage evaporators and preheaters. In ground waters, as the gases are driven off, normal carbonates precipitate. The apparatus is fitted with a filter to remove this precipitate.—*Wayne L. Denman.*

NEW BOOKS

L'analyse des eaux. Georges Rodillon. Paris: 1925. 2 vols., 429 pp., 24 fr. Reviewed in Bull. soc. hyg. aliment., **14**: 213–4, 1926. From Chem. Abst., **20**: 3202, October 10, 1926.—*R. E. Thompson.*

The Fatigue of Metals. **(With chapters on the fatigue of wood and of concrete.)** H. F. Moore and J. B. Kommers. New York and London: McGraw-Hill Book Co. Inc. Cloth; 6 x 9 inches; pp. 326. $4. Reviewed in Eng. News-Rec., **98**: 991, June 16, 1927.—*R. E. Thompson.*

Practice of Municipal Administration. L. D. Upson. New York and London: the Century Co. Cloth; 6 x 9 inches; pp. 588. $4. Reviewed in Eng. News-Rec., **98**: 993, June 16, 1927.—*R. E. Thompson.*

Manual of the Endurance of Metals Under Repeated Stress. H. F. Moore. New York City: Engineering Foundation. Cloth; 5 by 8 inches; pp. 63. $1. Reviewed in Eng. News-Rec., **99**: 112, July 21, 1927.—*R. E. Thompson.*

Hydraulics. Ernest W. Schoder and Francis M. Dawson. New York and London: McGraw-Hill Book Co. Inc. Cloth; 6 by 9 inches; pp. 371. $3.50. Reviewed in Eng. News-Rec., **99**: 111, July 21, 1927.—*R. E. Thompson.*

The Municipal Year Book for 1927. C. F. Bulpitt, Editor. London: The Municipal Journal. Cloth; 6 by 9 in.; pp. 900. 15s. Reviewed in Eng. News-Rec., **99**: 278, August 18, 1927.—*R. E. Thompson.*

Lubrication and Lubricants. Leonard Archbutt and R. Mountford Deeley. London: Chas. Griffin and Co.; Philadelphia: J. B. Lippincott Co. Cloth; 6 by 9 inches; pp. 650. $15. Reviewed in Eng. News-Rec., **99**: 441, September 15, 1927.—*R. E. Thompson.*

The Calculation and Design of Turbines and Water Power Plants. P. Holl. Revised by E. Glunk, with the assistance of Oskar V. Miller. (German) 4th Edition, 1927, 197 pages, 41 charts and 6 tables. Publisher, R. Oldenbourg, Munich and Berlin, Germany. A relatively short but decidedly interesting volume, treating the subject in a style somewhere between that of a textbook and a bandbook. More than a third of the book is used in setting forth detailed examples of pertinent hydraulic calculations, summarized design and operating data on unusually important installations, equations for various hydraulic and mechanical phenomena, general design data and a classified bibliography on hydraulic principles, turbines and water power plants. The body of the test is concerned with discussions of the development and design of turbines, design of plants for electric power development, details of water power development, cautions and observations as to water power potentialities and design of centrifugal pumps, shafts and wells. Published in clear and attractive form.—*Abel Wolman.*

Bulletin of the National Research Council. The National Academy of Sciences, Washington, D. C. No. 60, July, 1927. A compilation of industrial research laboratories in the United States, including consulting research laboratories. In addition to the alphabetical list of laboratories, which carries all the information, there is given a subject classification.—*A. W. Blohm.*

Report of the Department of Public Utilities (Cleveland, Ohio). 1926. The Baldwin Fairmount project (pumping station, filter plant and reservoir) was put into operation October 1, 1925. The Fairmount pumping station has a capacity of 300,000,000 gallons per day. The Baldwin filter plant, equipped with 40 filters has a total capacity of 166 million gallons per day. Baldwin reservoir has 135,700,000 gallons capacity. The Hoffman, Frazier and Heron Report adopted in 1920, as the basis for expansion of water supply system for Cleveland and metropolitan district, recommends a third lake tunnel, pumping station, filter plant and reservoir unit by the end of 1930. Immediate future and the next ten years of the water works is dependent upon increased revenue from a new schedule of water rates.—*A. W. Blohm.*

Comparative Tests of Six-Inch Cast Iron Pipes of American and French Manufacture. S. N. Petrenko. Technologic Papers of the Bureau of Standards, No. 336, 1927. "Comparative tests were made on 6-inch cast-iron pipe manufactured in France and on similar pipe manufactured in this country. The pipes were of "bell and spigot" type and were cast in sand molds. Tests, which included hardness, transverse, ring, shear, impact and hydrostatic tests, indicated that the strength of French pipe lay within the range of variation of the American pipe. Its deflection in transverse test was much lower than that of American pipe. French pipe was also characterized by greater hardness, low impact values, and a higher content of phosphorus (about 1.85 per cent) than in American pipe. Compressive test of the rings cut from the pipe seemed to give results which are fairly representative of the properties of the pipe, and is suggested as a substitute for transverse test of arbitration bars or coupons."—*A. W. Blohm.*

Metered Combustion Control, Manchester Street Station, United Electric Railways Company, Province, R. I. A. S. Davis. Reprint distributed by the Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. The rate of combustion is regulated according to the steam demand by a master controller connected to the steam header so that it responds to drop in pressure due to flow of steam and sets up an electrical control current proportional thereto. This current coöperates with control devices which actually meter the pulverized coal and the air supplied to burn it, to hold the two in a definite ratio and in proper amount to meet the steam demand. It is stated that the use of this equipment has resulted in more uniform steam pressure, and hence in more efficient operation of turbines, also in more uniform furnace conditions with lower excess air, resulting in higher boiler efficiency and lower furnace maintenance. Finally, the operators have been relieved of practically all of the physical work of operating the boiler, with the result that they are now able to pay closer attention to the finer details and to the better operation of the plant as a whole. Charts from recording instruments show a remarkably constant percentage of excess air and a uniform steam pressure, in spite of a rapidly fluctuating steam flow incidental to load swings in a traction plant. The percentage of CO_2 is set to be maintained as high as is compatible with economical operation of the furnaces, taking into consideration maintenance, combustible in ash and combustible loss up the stack, as well as heat lost in flue gases.

Manual of Dehydrated Culture Media and Reagents, Digestive Ferments Company, Detroit, Michigan. Describes in detail complete list of dehydrated culture media and other bacteriological laboratory products prepared by the Digestive Ferments Company. The exact formula of each medium is given wherever such a formula is possible. A short history of the development of the medium with references to the original papers is included. The particular uses of the medium are discussed and the method for preparing it from the dehydrated powder is given in detail.

The various ingredients for culture media are each discussed in a similar manner, as are also some of the more rarely used organic chemicals. One portion of the booklet is devoted to serological reagents.

The media and reagents are grouped in sections according to similarity of use or type. One section, for instance, is descriptive of media prepared according to the requirements of "Standard Methods of Water Analysis 1925" and the following section lists a number of other media of importance to bacteriologists engaged in water examinations. The book is completely indexed and is in convenient pocket size. It should be very serviceable for students and for all laboratory workers and technicians. Copies are available for distribution without charge upon application to the Digestive Ferments Company.

Die Binnengewässer Mitteleuropas. August Thienemann. Bd. I, 1925, 255 pp. Published by E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart. Abstracted by C. Juday in Science, **64**: 1647, 93, July 23, 1926. This book is the first of a series of seven which deals with the physical, chemical and biological features of inland waters of central Europe; it is an introductory volume to the six which are to follow. The book is divided in five parts in which the following types of water are discussed: (*a*) Underground Waters; (*b*) cold fresh water springs; (*c*) flowing waters; (*d*) standing waters, and (*e*) thermal and brackish waters. More than half of the text deals with various phases of limnology. The ecological features of various aquatic habitats are especially emphasized. Light, dissolved oxygen, current, temperature, and salt content greatly influence the number, type and class of plants and animals found in the water.—*A. W. Blohm (Courtesy U. S. P. H. Eng. Abst.).*

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